copy 4

JUN 30 1928

Volume VIII June, 1928 Number 3

THE JOURNAL OF DENTAL RESEARCH

(Continuing the Journal of the Allied Dental Societies)

EDITED BY

ELMER S. BEST
Minneapolis
THEODORE B. BEUST
Louisville
ARTHUR D. BLACK
Evanston, Ill.
FRANZ BOAS
New York City
C. F. BÖDECKER
New York City
R. W. BUNTING
Ann Arbor, Mich.
H. E. S. CHAYES
New York City
KAETHE W. DEWEY
Pittsburgh
MARTIN DEWEY
New York City
WM. B. DUNNING
New York City
A. C. FONES
Bridgeport, Conn.
HENRY W. GILLETT
New York City
WILLIAM K. GREGORY
New York City
MILO HELLMAN
New York City
PERCY R. HOWE
Boston
ANDREW HUNTER
Toronto
V. H. JACKSON
New York City
E. V. MCCOLLUM
Baltimore
FREDERICK S. MCKAY
New York City
JOHN A. MARSHALL
San Francisco
ARTHUR H. MERRITT
New York City
L. M. S. MINER
Boston
FREDERICK B. NOYES
Chicago
WESTON A. PRICE
Cleveland
M. L. RHEIN
New York City
E. C. ROSENOW
Rochester, Minn.
F. V. SIMONTON
San Francisco
KURT H. THOMA
Boston
R. H. VOLLAND
Iowa City
M. L. WARD
Ann Arbor, Mich.
B. W. WEINBERGER
New York City
WM. H. WELKER
Chicago
J. LEON WILLIAMS
New York City

PROPERTY OF DENTAL LIBRARY UNIVERSITY OF MICHIGAN DON'T MUTILATE OR REMOVE

Editor for the First District Dental Society of the State of New York
which in 1906 established the Journal of the Allied Dental Societies, now the oldest non-commercial journal in dentistry
JOHN OPPIE MCCALL, New York City

Editor for the New York Academy of Dentistry
MALCOLM W. CARR, New York City

Editor for the Robert R. Andrews Society for the Promotion of Research
SIMON OZARIN, Dental School of Tufts College

Editor for the Harriet Newell Lowell Society for Dental Research
HAROLD E. TINGLEY, Dental School of Harvard University

Editor for the William Jarvie Society for Dental Research
MELVILLE HUMBERT, Dental School of Columbia University

Editors for the International Association for Dental Research
Ann Arbor Section—U. G. RICKERT, Secretary
Boston Section—FRED R. BLUMENTHAL, Secretary
Chicago Section—EDWARD H. HATTON, Secretary
Halifax Section—GEORGE K. THOMSON, Secretary
Minnesota Section—DANIEL E. ZISKIN, Secretary
New York Section—BISSELL B. PALMER, JR., Secretary
Pittsburgh Section—LAWRENCE E. VAN KIRK, Secretary
St. Louis Section—CLARENCE O. SIMPSON, Secretary
San Francisco Section—JOHN S. SHELL, Secretary
Toronto Section—W. E. CUMMER, Secretary
Association—WILLIAM J. GIES, Secretary, New York City; *Executive Officer of the Board of Editors*

PUBLISHED BI-MONTHLY
AT MT. ROYAL AND GUILFORD AVENUES, BALTIMORE, MD.
BY THE JOURNAL OF DENTAL RESEARCH, INC.
EDITORIAL OFFICE: 437 West 59th St., New York City
Copyright, 1928, by the Journal of Dental Research, Inc.

Entered as second-class matter June 24, 1919, at the Post Office at Baltimore, Maryland, under the act of March 3, 1879

Made in United States of America

Important Books Received

Dental materia medica and therapeutics, with special reference to the rational application of remedial measures to dental diseases. By Hermann Prinz, A.M., D.D.S., M.D., Sc.D., Professor of Materia Medica and Therapeutics, Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania. *Sixth edition.* 1926: pp. 632; 7 x 4½ in.; 146 illustrations; $6.00. C. V. Mosby Co., St. Louis.

Technic of oral radiography. By Clarence O. Simpson, M.D., D.D.S., F.A.C.D. 1926: pp. 207; 6¼ x 4 inches; 165 illustrations; $5.00. C. V. Mosby Co., St. Louis.

Orthodontics: an historical review of its origin and evolution. *Two volumes.* By Bernhard Wolf Weinberger, D.D.S., Librarian of First District Dental Society of the State of New York, and Advisory Librarian, Dental Department, New York Academy of Medicine, New York City. 1926: pp. 1011; 7¼ x 4¾ in.; 599 illustrations; $25.00 (*two volumes*). C. V. Mosby Co., St. Louis.

American text-book of operative dentistry. By Marcus L. Ward, D.D.S., D.D.Sc., F.A.C.D., Editor; Professor of Dental Metallurgy and Crown and Bridge Work, and Dean, College of Dental Surgery, University of Michigan. *Sixth edition.* 1926: pp. 818; 7¼ x 4¼ in.; 783 illustrations; $10.00. Lea and Febiger, Philadelphia and New York.

A textbook of exodontia—exodontia, oral surgery, and anesthesia. Leo Winter, D.D.S., Professor of Oral Surgery, College of Dentistry, New York University. 1927: pp. 364; 7¼ x 4¼ in.; 329 illustrations; $7.50. C. V. Mosby Co., St. Louis.

Harelip and cleft palate (cheiloschisis, uranoschisis, and staphyloschisis). By Matthew N. Federspiel, B.Sc., D.D.S., M.D., F.A.C.S., Professor of Oral Surgery, Marquette University. 1927: pp. 200; 6¼ x 4 in.; 156 illustrations; $5.00. C. V. Mosby Co., St. Louis.

A text-book of bacteriology for dental students. By Arthur Bulleid, L.R.C.P. (London), M.R.C.S., L.D.S. (England), Assistant Dental Surgeon and Assistant Bacteriologist, Guy's Hospital, London. 1927: pp. 219; 6¼ x 4 in.; 60 illustrations; $4.50. C. V. Mosby Co., St. Louis.

Lectures [6] on the biologic aspects of colloid and physiologic chemistry. A series of lectures given at the Mayo Foundation and the Universities of Minnesota, Iowa, Washington (St. Louis), and the Des Moines Academy of Medicine, Iowa. By six investigators in the field. Introduction by Louis B. Wilson, M.D., Director of the Mayo Foundation for Medical Education and Research. 1927: pp. 244; 6¼ x 3¾ in.; 85 illustrations; $2.50. W. B. Saunders Company, Philadelphia and London.

American illustrated medical dictionary. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., member of the Committee on Nomenclature and Classification of Diseases, American Medical Association, and Editor of the "American Pocket Medical Dictionary;" with the collaboration of E. C. L. Miller, M.D., Professor of Bacteriology and Biochemistry, Medical College of Virginia. *Fourteenth edition.* 1927: pp. 1388; 8¼ x 4¾ in.; 319 illustrations; flexible binding—plain, $7.00; thumb index, $7.50. W. B. Saunders Company, Philadelphia and London.

Dental education in the United States and Canada. By William J. Gies, M.S., Ph.D., Sc.D., LL.D., F.A.C.D., Professor of Biological Chemistry, Columbia University; Executive officer of the Board of Editors, *Journal of Dental Research;* with a preface by Henry S. Pritchett, Ph.D., Sc.D., LL.D., Litt.D., President of the Carnegie Foundation for the Advancement of Teaching. 1926 (issued in 1927): pp. xxii + 692; 7¼ x 5 in.; one illustration; distributed free of charge on application, by letter or in person (the volume is "Bulletin No. Nineteen"). Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York City.

Physical chemistry and biophysics, for students of biology and medicine. By Matthew Steel, Ph.D., Professor of Biological Chemistry, Long Island College Hospital. 1928: pp. 372; 7¼ x 4¾ in.; 38 illustrations; $4.00. John Wiley and Sons, Inc., New York City.

Fundamental principles of a systematic diagnosis of dental anomalies, with an explanation of a new classification based upon gnathostatic methods of investigation. By Paul W. Simon, Head of the Department of Orthodontics, Dental Institute, University of Berlin. *Translated* by B. E. Lischer, D.M.D., F.A.C.D., Non-resident Lecturer on Orthodontics, Dental School, University of Michigan. 1926: pp. 378; 6¼ x 4 in.; 189 illustrations; $5.00. Stratford Company, Boston, Mass.

The practice of periodontia. By Sidney Sorrin, D.D.S., Chief of Periodontia Clinic, and Samuel C. Miller, D.D.S., Instructor, Periodontia Clinic, College of Dentistry, New York University. 1928: pp. 160; 6 x 3¾ in.; 122 illustrations; $3.50. MacMillan Company, New York.

The romance of the atom. By Benjamin Harrow, Ph.D., Associate in Biological Chemistry, Columbia University. 1927: pp. 162; 5⅓ x 3¼ in.; 7 illustrations; $1.50. Boni and Liveright, New York.

The nature of matter, gravitation, and light. By Albert P. Mathews, Ph.D., Professor of Biochemistry, University of Cincinnati. 1927: pp. 222; 6⅝ x 4 in.; 7 illustrations; $7.00. William Wood and Co., New York City.

The religion called behaviorism. By Louis Berman, M.D., Associate in Biological Chemistry, Columbia University. 1927: pp. 153; 5⅓ x 3¼ in.; no illustrations; $1.75. Boni and Liveright, New York.

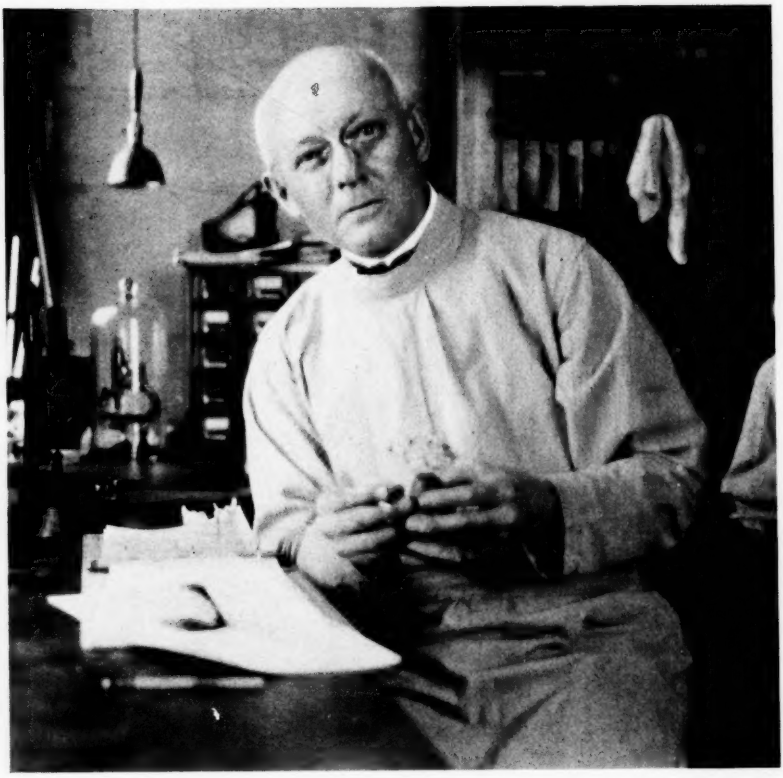
Dental state board questions and answers. By R. Max Goepp, M.D., Professor of Principles and Practice of Medicine and of Clinical Medicine, Woman's Medical College of Pennsylvania, Philadelphia. *Fourth edition.* 1928: pp. 463; 7¼ x 4¾ in.; no illustrations; $4.50. W. B. Saunders Co., Philadelphia and London.

American universities and colleges. By David A. Robertson, Assistant Director, American Council on Education, Washington, D. C. 1928: pp. 884; 7¾ x 5¼ in.; no illustrations; $2.50. Charles Scribner's Sons, New York and London.

An introduction to organic chemistry. By Alexander Lowy, Ph.D., Professor of Organic Chemistry, University of Pittsburgh; and Benjamin Harrow, Ph.D., Associate in Biological Chemistry, Columbia University. *Second edition.* 1928: pp. 407; 7 x 4 in.; 22 illustrations; $3.00. John Wiley and Sons, Inc., New York.

A text-book of general bacteriology. By Edwin O. Jordan, Ph.D., Professor of Bacteriology, University of Chicago and Rush Medical College, Chicago, Ill. *Ninth edition.* 1928: pp. 778; 7¼ x 4¾ in.; 191 illustrations; $6.00. W. B. Saunders Co., Philadelphia and London.

UNIV. OF MICH.



CLARENCE JONES GRIEVES

A TRIBUTE TO CLARENCE JONES GRIEVES[1]

HARRY E. KELSEY
Baltimore, Maryland

I

Clarence Jones Grieves, son of Edward Weldin and Lucretia Jones Grieves, was born in Wilmington, Delaware, October 23, 1868. His family came to Baltimore about 1881, where he resided until his death, which occurred on Friday, November 4, 1927. He is survived by his widow, Hannah Ramsey Grieves; one son, Edward W. R. Grieves; one grandson, Edward Rutledge Grieves; and his stepmother, Laura S. Grieves.

Dr. Grieves received his education in the public schools of Wilmington and Baltimore, and graduated in one of the first classes of the Polytechnic Institute, in Baltimore, after it was organized. His father, a mechanical engineer, was connected at different times with the Harlan and Hollingsworth Company, the Baltimore and Ohio Railroad Company, and other companies interested in fuel and transportation. Through interest aroused by his studies at the Polytechnic Institute, and association with his father's work, Dr. Grieves on leaving school entered the service of the Baltimore and Ohio Railroad. But he soon became attracted to dentistry through the influence of Dr. Richard Grady, who had been associated with the inception of the Polytechnic Institute, and entered the Dental Department of the University of Maryland, graduating in the class of 1888.

Upon graduation, he was immediately appointed Assistant Demon-

[1] The portrait on the opposite page (enlarged about one-third) was "discovered by Dr. Shipley among some of Dr. Grieves' things in the laboratory, and is without doubt the latest picture of Dr. Grieves before his illness. . . . . It was taken in the Hunterian Laboratories one day, as were also pictures of some of the others there, as a matter of fun, and without any thought of ever being published. It is different from the one published in the other journals, and unquestionably a far better likeness of him." [Quoted from a letter by Dr. Kelsey to the *Journal*—(*Ed*).]

strator in Operative Dentistry, which position he held until 1892, when he was made Assistant Professor of Crown and Bridge Work, holding this position until 1906. He was then called to the Professorship in Comparative Anatomy and Histology, in the Baltimore College of Dental Surgery, remaining in that capacity until 1917, when he resigned to enter the service of the United States. In 1913, through the efforts of Dr. Grieves, a Dental Clinic was established at the Johns Hopkins Hospital. He was made Chief of Staff, but resigned about 1925, when his health made it impossible to give the work further attention. In 1917 and 1918 Dr. Grieves' college work was interrupted for the first time after his graduation. During these years he served as Lieutenant in the Naval Reserve; also as special instructor in the Dental Corps, and Dental Consultant in the Hospital, at Great Lakes Training Station. He was also an instructor in the Army and Navy Dental School in Washington, and Lecturer in the Dental Department of the Naval Medical School.

He became a Fellow of the American College of Dentists at the time of its organization, having been one of the charter members. Among the honorary distinctions bestowed upon Dr. Grieves was the Master of Arts Degree, awarded in 1921 by the University of Michigan. In 1922, the Connecticut State Dental Association awarded him the Newell Sill Jenkins medal, given annually to the man who is considered to have made the most outstanding contributions to dental science during the year. Two other medals were conferred upon Dr. Grieves for practically the same reason; the Callahan medal, conferred yearly by the Ohio State Dental Society, and the Jarvie medal and Fellowship, conferred by the New York State Dental Society. Seeking a suitable way in which to honor him, his own State Dental Association, in 1925, voted a considerable fund from its treasury for the support of a library, to be known as the Clarence J. Grieves Library Foundation. As a nucleus, Dr. Grieves gave his own personal library, which has been increased both by the annual income of the Foundation, and by numerous contributions from friends and admirers of Dr. Grieves in the profession and among publishers, so that the Library is rapidly becoming of great value, especially as it is located in the Baltimore College of Dental Surgery, at the University of Maryland, where it is accessible alike to students and members of the profession. He was

also made an honorary member of the American Society of Orthodontists, and numerous state societies, and other organizations.

Dr. Grieves began his career of study and investigation of dental problems almost at the time of his graduation from the University of Maryland Dental Department in 1888, and continued to be one of the most strenuous workers along these lines. None of the literature during the early years of his practice escaped him, and he very early began to make valuable contributions to it. His study of the various metals used in the construction of orthodontic appliances was his first valuable contribution other than reports of clinical evidence secured by observation or experiment in the mouth. It was thought desirable to have someone make an investigation who would not be prejudiced in his original views, and therefore someone other than an orthodontist was selected. Dr. Grieves had already established a reputation that led to his being asked to undertake this particular work. About the same time he made an exhaustive study of the effects of heat on porcelain teeth, during soldering, which added valuable data to the knowledge of that subject.

He then became deeply interested in the subject of focal infections, and conducted research in this subject, in conjunction with Dr. Baer and other physicians and surgeons who were early interested in this field, continuously until his death. During this long period he contributed voluminously to the literature, his field of observation having been greatly broadened by the material constantly passing through the Dental Clinic of the Johns Hopkins Hospital. Among other contributions were some studies of the literature relating to endocrinology in its relation to development of the teeth and supporting structures.

His most recent and perhaps most valuable work was that on which, at the time he became ill, he was engaged at the Hunterian Laboratories of the Johns Hopkins Hospital, in conjunction with Drs. McCollum and Shipley. Dr. Grieves reported some of his findings on the effects of experimental diets upon the teeth of rats, having made studies of the teeth and jaws of more than twelve hundred.

His long and faithful service in various dental societies—including the National, of which he was an active member, serving in an administrative capacity in almost every position, and others of which he was

either an active or honorary member—attest the esteem and regard in which he was held by the profession as a whole.

In private practice Dr. Grieves was always successful from the beginning, and had a large clientele. His patients were also his friends, and many join his family and colleagues in mourning his untimely death. For several years after his graduation, Drs. Grieves, Richard Grady, and H. A. Wilson were associated at the same address on Howard Street. Later he moved from there to the corner of Park Avenue and Madison Street, which property he purchased and occupied as his office until his health necessitated discontinuance of practice.

Personally he was one of the most genial and delightful of companions, and he had hundreds of intimate friends in the profession throughout the country, who remember well his keen sense of humor and kindly disposition. His private life was exemplary in every way. He had a generous and hospitable nature, and discharged every obligation to his family and society with the utmost fidelity. He was never happier than when sharing his delightful home and home-life with his friends. He was cut off suddenly in the flower of his success, but his example and work will continue to live and bear fruit.

A bibliography of the writings of Dr. Grieves would be too long to append here, but among the most outstanding contributions which might be mentioned are:

"Patent instruments but not methods."	1898 Items of Interest.
"The porcelain facing soldered and checked."	1909 Dental Cosmos.
"The behavior of certain metals in the mouth: base and noble metal appliances in orthodontia."	1910 American Society of Orthodontists; Items of Interest.
"Infections resulting from lowered vitality caused by unhygienic mouths."	1913 Dental Cosmos.

"Dental periapical infection as the cause of systemic disease."	1913	National (American) Dental Association; Dental Cosmos.
"A classification of teeth, the diseased pulps and apices of which are related to infective focal and systemic sequelae."	1920	Journal of the National (American) Dental Association; Journal of Dental Research.
"The importance of deciduous and first permanent molars in normal occlusion, and the incidence of both groups as systemic infection foci."	1921	Dental Cosmos.
"A preliminary study of gross maxillary and dental defects in three hundred rats on defective diet."	1922	Journal of the National (American) Dental Association; Bulletin of the Johns Hopkins Hospital.
"The relation of nutrition to teeth."	1922	Proceedings of the American Child Hygiene Association.
"The effect of defective diets on teeth. The relation of calcium, phosphorus, and organic factors to caries-like and attaching tissue defects."	1922	Journal of the American Medical Association.

The following tributes to the character and life work of Clarence Grieves, from men widely known in their particular fields of research, speak eloquently of the regard and esteem he inspired among those with whom he was associated.

II

Throughout an experience of nearly forty years in the practice of dentistry it has been my good fortune to know many of its pioneers and leaders. Among this array of brilliant men who have made professional history and produced works of great scientific value to the profession, which have, in turn, reflected benefit to the world at large, no character seems to stand out so prominently, particularly in the line of scientific attainment, as that of Clarence Jones Grieves.

He was a scientist who was slow to come to a conclusion and make pronouncement; but when a statement of fact was made without qualification, it was so true and well thought out that any one could use it as a basis for further investigation, feeling sure that every thing back of it had been carefully analyzed and sound conclusions reached. One of his earlier investigations, which covered the behavior of the base metals in the mouth in orthodontic appliances, was so conclusive that it practically barred the use of the base metals in orthodontics, and caused the manufacturers to produce precious metals having a better qualification than the metals which had been displaced. Perhaps the greatest piece of work he ever did—one that exacted more exhaustive inquiry and research than any other— was his classification of pulpless teeth, an effort that required time, thought, and analysis. It stands to day as one of the classics in our professional literature. I have frequently made the statement, and now reiterate, that no one has succesfully controverted the conclusions he reached in this essay.

I feel sure that, if Dr. Grieves had lived a little longer, we would know more about the decay of the teeth, because his investigation of the condition of the teeth of rats that had been fed a defective diet (this work being done in collaboration with Drs. McCollum and Shipley of the School of Hygiene and Johns Hopkins Hospital) seems to offer a great field wherein to find the truth as to the relation of nutrition to decay. Indeed, so much so that his results might have revolutionized preventive dentistry. I know, from my personal contact with him, that he felt our greatest need was a more comprehensive knowledge of the relation of nutrition to structural defects in the teeth.

We all feel the loss of this great man. The work in this particular line has received a check that is most unfortunate. It is hoped that

Dr. Grieves's mantle will fall upon one who can successfully carry on this work, which means so much to our profession and the world at large. It is my judgment that he was the greatest dental scientist of his day. It was his ability to sift the chaff from the wheat; to separate essentials from non-essentials; to recognize the fundamental principles involved in any scientific subject. These are the qualifications that cause his writings to stand out as works of true merit.

The following quotation seems eminently to fit his character:

"To live as gently as I can;
To be no matter where, a man;
To take what comes of good or ill,
And cling to faith and honor still;
To do my best and let that stand,
The record of my brain and hand;
And then should failure come to me,
Still work, and hope for victory.

"To have no secret place wherein
I stoop unseen to shame and sin;
To be the same when I'm alone,
As when my every deed is known
To live undaunted, unafraid
Of any step that I have made;
To be without pretense or sham,
Exactly what men think I am."

THOMAS P. HINMAN, Atlanta, Ga.

III

My acquaintance with Clarence Grieves was threefold in character. I came to know him first as his patient. As our acquaintance ripened, he came to be my true and sincere friend. Later still, our association in the laboratories of the Johns Hopkins Medical School brought me into a full knowledge of his achievements in the field of biological science, into which his natural interests and long years of training had led him; and we "carried on" side by side, as colleagues and coworkers, during all those hours he snatched I never knew how, at no inconsiderable pecuniary sacrifice, from days filled to overflowing—filled

with the multifarious demands of a busy practice, and all the other interests that claimed his ungrudged attention. While this short tribute should perforce deal with Grieves' scientific work as I knew it—and I count myself fortunate in being able to say that perhaps in this respect I was closer to him than any of his other colleagues—and while a record of his scientific accomplishments and attainments would more than suffice to fill any space that may be at my disposal, I find myself unable to consider him from this single point of view alone, and I cannot tell of Grieves the laboratory worker apart from Grieves the friend. He played, on those rare occasions when he did play, with the same intensity that he devoted to his work. I treasure in memory long drives with him through the Maryland countryside, the history of every inch of which he knew; journeys to and from scientific meetings; and, best of all, those luncheon hours in the Rennert Grill where the waiter who yielded allegiance to no other man found for him the best the House could furnish. And Clarence Grieves' knowledge of Maryland cookery was equal to his knowledge of the teeth, which were so vital in its consumption.

Our scientific connection began, characteristically enough, one morning in 1920 while I was seated in his operating chair. For some time I had been engaged in studying the pathological changes in rats which had been kept on various normal and faulty diets, and, having experience with the pronounced defects of those diets on their bones, had evolved an idea—new to me at the time, but old in Grieves' mind as the sequel showed—that food must also exert a profound influence on dental anatomy and pathology. With this in mind I broached the subject to Dr. Grieves, and added as a corollary a request for information of perhaps some student of dentistry well grounded in the fundamental sciences who would be willing to examine the teeth of my animals, and to study them from an anatomical and pathological viewpoint. His decision was as always instantaneous, and his answer as always brief: "Doctor, 'there ain't no such animal';" then, after a moment's pause: "I should like to take it on myself, and I will." The scene is before my eyes while I write this as though it had been enacted yesterday. I was of course overjoyed, for this personal response to my plea for aid was totally unexpected, and never for a moment during the course of years did my joy about his decision abate.

It seems almost superfluous to discuss the results of his study—studies which no one but a man with his background could have carried on. Everyone engaged in dental work and investigation knows what he accomplished—the correlation of faulty diet with dental disease—an honor which he shared with Mrs. Mellanby in Britain. No one but I, however, can realize of what he stood on the brink, and even I can realize only in part. Of one thing I am sure: yet a little while, and he could have told us of the association of particular dental diseases with specific dietary errors.

I feel that, in discussing Grieves' accomplishments, perhaps I should stress one achievement which I regard as among his most far reaching. I refer to the evolution of a new method for the preparation of histological sections showing side by side the hardest and the softest tissues of the mammalian body—the enamel and the pulp of the tooth—a method without which no adequate study of dental pathology or histology is possible. By his method teeth can be studied without decalcification, and with the calcified and soft tissues maintained in the relation they held to each other in vivo. In other words, he did for dental histology what Ehrlich did for the histology of the blood, and what Golgi, Ramon y Cajal, and del Rio Hortega have done for the central nervous system. When this method has been applied and has yielded its full results, I trust and believe that the dental profession will feel toward Grieves as the neurologist does toward Golgi. By its use he himself was able to show the resorption of the roots of teeth following the ingestion of diets low in calcium, and to demonstrate the analogy of the process to that which procures the resorption of the roots of the deciduous teeth.

Grieves' joy when we finally succeeded in producing carious teeth in our animals was a measure of his enthusiasm. For months he had said from time to time: "If we could only get caries in these molars in which caries is never found under natural conditions, I think we would be able to throw some light on the underlying cause of the disease." I think that, no doubt, this would have been the case; but unfortunately he was not permitted to follow up and complete the studies in which he had made so much progress, and the foundation of which he had laid so well. It was just at this point that his work was brought to a close. I hoped at first, as we all did who were his friends, that the

sudden illness which so shocked those who knew him was only a temporary check—perhaps a salutary warning—but as time went on, we knew that Clarence Grieves' work was finished forever. There can be no doubt that in the years which are to come other hands will take up the instruments which he let fall and other minds will work out to their finish the problems which he formulated. The work which he began is too important to be allowed to come to a halt, and will of necessity be continued to its end. To estimate its value is impossible, for there is no measure which can be applied to judge it.

PAUL G. SHIPLEY, Baltimore, Maryland

IV

My acquaintance with Dr. Grieves began as the result of his interest in the study of the teeth and skulls of the animals which we were employing in the Department of Biochemistry of the School of Hygiene and Public Health. He saw clearly the possibilities of the study of a group of experimental animals representing various types and degrees of malnutrition, the natures of which could be fairly accurately described. I was delighted when he proposed to study such skulls as we might be able to give him, and we spared no effort to prepare a long series over which he spent many an afternoon.

Grieves had the true scientific spirit. He had studied the literature of dental disease as thoroughly as any man ever did, and his mind had worked over various problems until he had clearly defined a long series of questions to which he wanted answers. He was immensely interested in the study of his own and the material of others, and used to take great pleasure in relating to me his findings and giving me his interpretation of what they meant. He published three papers embodying the results of his studies on our material, which have unusual merit and have received wide recognition. I always found him interesting and entertaining, whether he was pointing out some peculiarity in a specimen, enlightening me upon some subject in dental pathology, discussing the future of the dental profession, for which he held the highest possible ideals, or telling a story, of which he had a goodly stock. He was a good fellow. I have missed his cheerful visits, his engaging smile, his informing conversation, and his stimulating idealism. We shall not soon see his like again.

E. V. MCCOLLUM, Baltimore, Maryland

V

The scientific genius of Clarence Grieves is perhaps best expressed by his studies of diet and nutrition in their relationship to problems in dentistry. Through his friendship and close association with Drs. McCollum and Shipley, and others who were engaged in the study of nutrition in Johns Hopkins University, he had an unusual opportunity to follow the development of this work, and to observe the dental and maxillary disturbances in the experimental animals. His study of the skulls of these animals was made with such thoroughness, and his general conception of the problem was so well grounded, that he won the enthusiastic admiration of all members of the group. His opinion on skeletal changes in his field was considered authoritative; and, in several publications bearing on the dental phases of the problem, he was joint author with the nutrition group, and wholly responsible for the observations and deductions made. The character of these joint reports was such that they are today outstanding contributions to the study, and the basis upon which much of the later work has been founded.

RUSSELL W. BUNTING, Ann Arbor, Michigan

VI

A little more than fifteen years ago, Dr. Clarence Grieves, in commenting on the two now classic statements of Sir William Osler and Dr. Charles Mayo regarding the future scope of dentistry, said:

"These and many other equally earnest utterances from eminent authorities in all branches of the healing art point the trend and progress of modern medical thought leading to the obliteration of all atria for infection. They settle for all time the much-discussed question of the status and recognition of modern dentistry. Leaving nothing to be desired, they can be interpreted in but one way, viz., that the public generally and all allied specialists are willing and anxious to grant dentistry her due recognition in a realm even broader than she ever dreamed of, if the profession will accept the responsibilities and burden of the research which is a part of such recognition.

"The reverse is also true, and is implied, if not stated, viz., that if we are not capable of nor willing to accept this opportunity, which is said to come but once to all men, then will we be adjudged unfit for the professional recognition already attained, not alone by the other professions but by the whole

world, where nothing is granted which is not earned. Dentistry will then cease to be a profession, and will slowly but surely gravitate into a craft of skilled appliance-makers, the only position we then should deserve and could maintain."

This advance concept of the responsibility of dentistry was written in 1913, and speaks more for the vision and wisdom of Dr. Grieves than we could were we to write a volume. Dr. Grieves suspected that opportunity comes only once during the life of a man. It is indeed fortunate for the dental profession that he discovered and seized his great opportunity. During the hysteria of the early focal infection controversy, as related to dentistry, Dr. Grieves pointed the way toward a sane and constructive solution of the problem, thereby stemming the tide toward radicalism. Our profession is deeply indebted to him for both his painstaking investigations and his forward looking teaching. There is reason to believe that without his influence, and his studies of the problem, the profession might have gravitated backward to what he so tersely spoke of as a craft of skilled appliance-makers.

U. G. RICKERT, Ann Arbor, Michigan

VII

Perhaps it will be of interest to some readers, even of this scientific publication, to learn about the early life of Clarence J. Grieves, of his parents, and of the environments and childhood traits that had an influence on, or pointed to, those peculiar characteristics that distinguished his later life. He was born of parents whose ancestors, both paternal and maternal, had been for generations engaged in mechanical production. His paternal grandfather was an expert wood worker, and spent his spare time in a little work-shop in the cellar of his home. His special amusement was making things of cedar, although he worked other woods as well. Some of these articles survive today. The son, Edward W. Grieves, inherited his father's traits, and entered the employ of a large ship and car building company, in Wilmington, where he did expert interior wood finishing, becoming a master car builder, and rising to positions of responsibility, including superintendent of such construction. He married Miss Lucretia Clay Jones,

whose family were large owners, and officials, of the Harlan & Hollingsworth Co., of Wilmington, Delaware.

Through his mother's family, Dr. Grieves inherited a long line of ancestors associated with mechanical industries. Joseph Jones, Sr. (1795–1867) established a machine shop on the banks of the Brandywine, a few miles from Wilmington. Of an inventive mind he developed many mechanical ideas, including a tractor-drawn plow. Of his children and descendants one, John Jones, founded the house of Pusey and Jones, builders of heavy machinery and ships. Harriet Jones was the mother of T. Jackson Shaw, a designer of marine engines; Henry C. Jones was the founder and president for years of Hilles & Jones, manufactures of boiler and machine tools. Robert Holt Jones, D. D. S., was a well known dentist and the favorite uncle of Dr. Grieves. Thomas Jackson, Jr., a half-uncle of Dr. Grieves, was largely interested in ship building—an official of the Harlan & Hollingsworth Co.

With such a back-ground, Clarence Jones Grieves was almost of necessity an expert mechanic. He was in addition a painstaking student, even as a child. His marks were invariably good. An only child of strict Methodist parents, he was conscientious in all his acts, painstaking and persistent in the completion of any attempted task. The latter trait was to my mind his most marked characteristic in later life. He never attempted to write a paper or to make an investigation that he did not put into it his most profound thought, devoting his entire time and energy to its accomplishment. That was the secret of his success and the cause of his untimely break down. His loss seems irreparable, as thus far no one has been able to carry on his work. But, as long as we live, his memory will be cherished by those who knew him best.

GEORGE E. HARDY, Baltimore, Maryland

SOME FUNDAMENTAL FACTORS IN TOOTH ARTICULATION[1]

VICTOR H. SEARS, D.D.S.

Department of Prosthetic Dentistry, College of Dentistry, New York University, New York City

A clear conception of the underlying principles involved in any field makes the solution of a specific problem in that field more readily attainable; yet in the field of tooth articulation, a survey of the literature reveals a general lack of comprehension of the elemental factors concerned. As a natural result, we have too many recommendations as to tooth articulation that are either obviously arbitrary or at best empirical. This statement is not intended to cast aspersions upon the sponsors of the criticized suggestions, without whose efforts advancement might have been much slower. However, we must not allow our reasoning to be impaired by our reverence for pioneers and our respect for authority. Let us, then, muster the facts without bias and attack the problem of tooth articulation from the view point of impersonal research.

The subject of articulators having been dealt with elsewhere by the writer (6), it will not be elaborated here. Suffice it to say that the adjustable articulator is implied whenever a reference is made to the application of an articulator.

Aside from the articulator mechanism the effects of certain factors, such as cusp height, plane of orientation, and compensating curve, have been but partly understood. Consequently, each in its turn has played the rôle of a half truth. Hanau has done more than anyone else in this country to help the profession to solve the tooth articulation problem, and his work has made for greater clarity of conception and of expression than existed before his time. His "laws of articulation"

[1] The First District Dental Society of the State of New York hereby certifies that this paper was first presented by its author on October 31, 1926, in competition for the Morris L. Chaim prize offered annually by the First District Dental Society. [Received for publication on April 14, 1928.—(*Ed.*)]

(3) may be cited as an outstanding example of his work in this field. However, these laws have not been fully comprehended even to this

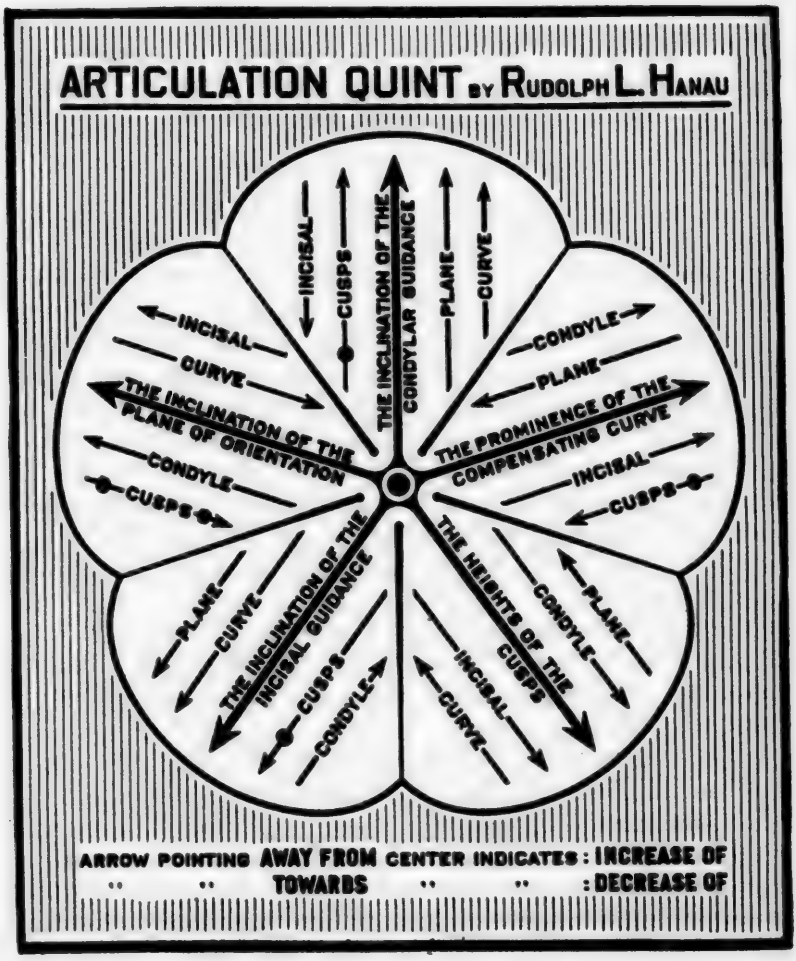


FIG. 1. Hanau's articulation quint

day. The influence of the compensating curve upon the other factors involved, is, under certain conditions, confusing to many dentists who attempt to apply the articulation quint (4). (See *fig. 1.*)

Hanau's "laws of articulation" are fundamentally correct. In general, so are the findings of his precursors (Balkwill, Walker, and Gysi), which have appeared from time to time in the dental literature since 1866; but their writings by no means exhaust the possibilities of tooth articulation, nor have the facts always been presented in such form that they are generally comprehensible. It is the ambitious aim of this essay to interpret in part the published writings of these authorities in such a manner that the dentist with an interest in the subject may gain a working knowledge of the necessary fundamentals involved. The essay also aims to indicate further advances in the chosen field.

A knowledge of the requirements of balanced articulation is presupposed (5). The setting up of teeth to balanced articulation is the problem before us. In order to simplify our problem we may assume, for the purpose of this discussion, that the mandibular teeth bear a fixed relation to the mandibular condyle, and that the condyle travels in even lines from a definite centric position to and from the various excentric positions. The mandible is a solid body capable of many and complex movements in the three dimensions of space, but for the purpose of study these complex movements may be dissolved into simple ones.

Let us first consider the movements of the mandible from the centric position to the position of incision. For the purpose of discussion, this movement may be conceived as occurring in a sagittal plane—upon which plane we shall illustrate it by drawings. *Figure 2* indicates that when the incisal and condyle indications are horizontal, and the plane of orientation is also horizontal, there will be a condition of balanced articulation from the centric to the protrusive relation. In this condition the mandibular masticatory surface may (in the absence of cusps as shown) be moved anteriorly or posteriorly, and will remain in continuous contact with the opposing surface throughout the movement.

If we erect perpendiculars upon the incisal and condyle guidances, these perpendiculars meet in infinity. If we erect perpendiculars at any points upon the occlusal surface in this plane they will be parallel to each other. In *fig. 3* perpendiculars erected upon the incisal and condyle guidances intersect at a point near the patient's head. This

point we shall designate the *articulating center*, because it is a center toward which all articulating surfaces, also called guidances (represented in the drawings as lines), must face in order to remain in contact throughout the movement.

The articulating center, then, is the center toward which all guidances face during balanced articulation. Stated another way: all

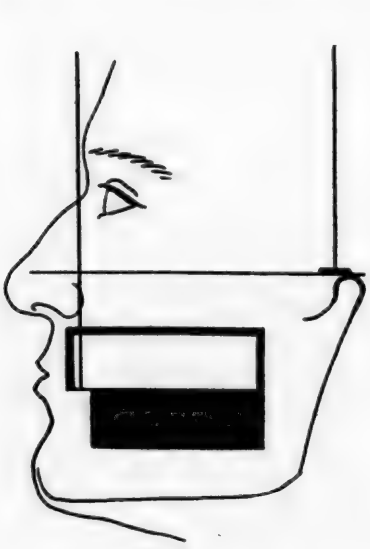


FIG. 2

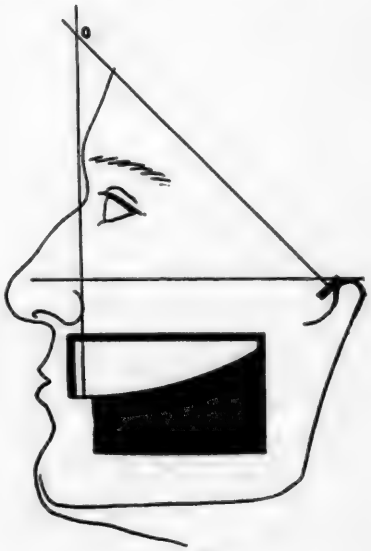


FIG. 3

FIG. 2. When the incisal and condyle indications are horizontal, and the plane of orientation is also horizontal, there will be a condition of balanced articulation from the centric to the protrusive relation.

FIG. 3. Perpendiculars erected upon the incisal and condyle guidances intersect at a point near the patient's head—O, the "articulating center."

guidances face toward a common center which we designate the articulating center.

In the drawings the movements are represented as occurring in a plane which, being of two dimensions, permits us to speak of a point instead of an axis. Later we shall consider articulation in the third dimension. We must fully realize that articulation actually occurs in three dimensions of space, i.e., on surfaces not in a common plane,

and that we are reducing this to a common surface (two dimensions only) for the purpose of study and discussion. By tilting the incisal guidance posteriorly, as in *fig. 4*, we bring the articulating center within the head and increase the curvature of the masticatory surface.

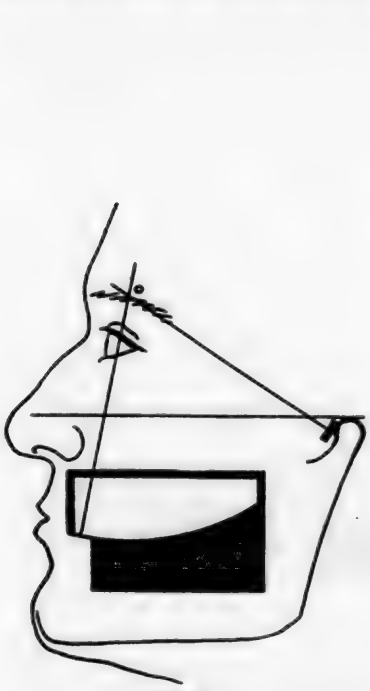


FIG. 4

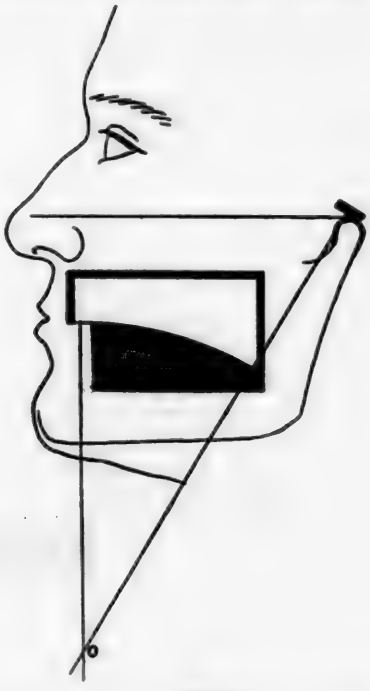


FIG. 5

FIG. 4. By tilting the incisal guidance posteriorly, the articulating center is brought within the head.

FIG. 5. When the condyle guidance is elevated to an angle greater than the incisal guidance, the articulating center lies below the masticatory surfaces.

Whenever the condyle guidance is elevated to an angle greater than the incisal guidance, as in *fig. 5*, the articulating center lies below the masticatory surfaces.

It is obvious from the foregoing that the inclinations of articulating surfaces (the mesial facets of the mandibular teeth in protrusive movement) are determined by the articulating center. *Figure 6* illustrates

an impossible condition. If we assume, as we do in this discussion, that the mandibular movement is determined by the incisal and condyle guidances, then the articulating surfaces of the teeth must lie at right angles to radii from the articulating center. In *fig. 6* the articulating center, as fixed by condyle and incisal guidances, lies directly above the head, but the articulating surfaces of the teeth face another direction. Any effort on the patient's part to protrude the mandible in a horizontal path would be resisted by an interlocking of the cusps shown in the figure.

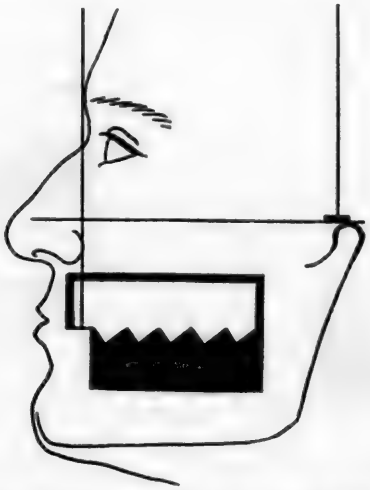


FIG. 6. An impossible condition, in which the articulating surfaces (the mesial facets of the mandibular teeth) do not face the articulating center. This condition precludes the attainment of balanced articulation.

When the incisal and condyle guidances are horizontal the tooth guidances must likewise be horizontal, but all of the tooth guidances need not necessarily be continuous. *Figure 7* shows how cusp height may be introduced even though the guidances are all horizontal. In similar fashion the plane of orientation (occlusal plane) may be horizontal even though the tooth guidances face an articulating center near the head as in *fig. 8*. We may even have a "reverse" curve, as in *fig. 9*, in which balance is still possible because the articulating tooth

surfaces face the articulating center. While this condition is not practical, it serves to indicate the application of the articulating center under extreme conditions. *Figure 10* shows another possibility, in which the articulating center lies in infinity, but not directly above the head. In this instance a "curve of Spee" is shown; but this curve may be reversed, or the "occlusal plane" may be without any curvature whatever. This drawing serves to indicate how one may get into

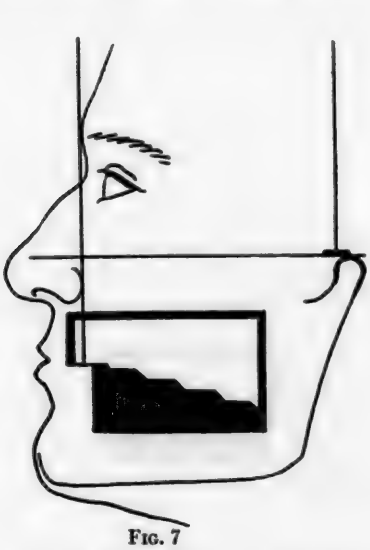


FIG. 7

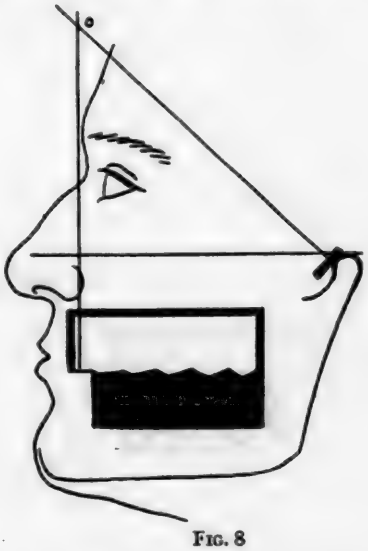


FIG. 8

FIG. 7. Cusp height may be introduced even though the guidances are all horizontal.
FIG. 8. The plane of orientation (occlusal plane) may be horizontal even though the tooth guidances face an articulating center near the head.

difficulties in attempting to assign to the "curve of Spee" any necessary relation to the incisal and condyle guidances.

All of these nine figures show that balance is possible only when the tooth guidances are directed toward the articulating center, as determined by the incisal and condyle guidances. On the mandibular denture it is the mesial slopes of the teeth which form the guidances in protrusive movement. The distal slopes of the mandibular teeth have no significance in this connection.

In the practical application of the foregoing, in the field of full denture prothesis, balance from the centric to the protrusive position may be readily obtained by facing the mesial slopes of the mandibular teeth toward the articulating center. The articulating center is easily visualized by imagining perpendiculars from the incisal and condyle guides of the articulator. To be mathematically correct straight incisal and condyle guides, such as are generally found on articulators, would connote shifting articulating centers; but this fact

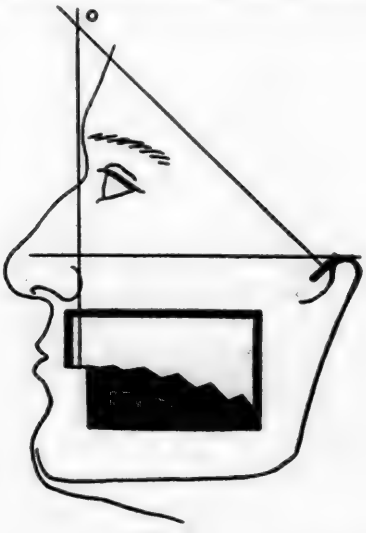


FIG. 9

FIG. 10

FIG. 9. A "reverse curve," in which balance is still possible because the articulating tooth surfaces face the articulating center.

FIG. 10. The articulating center lies in infinity, but not directly above the head. (A "curve of Spee" is shown.)

is negligible from a practical standpoint. For instance, in *fig. 11*, a locus of instantaneous centers will follow a line from O to O′. It also follows that, when the incisal and condyle guides are straight, the tooth guidances must also be straight. This should dispose of the controversy as to whether masticating movements are necessarily spherical. Monson's spherical theory, as commonly understood and as illustrated by his well known drawings (*fig. 12*), requires the articu-

lation of teeth in such a manner that the long axes of the posterior teeth coincide with radii of the center of the sphere. While it is undeniable that balanced articulation is possible with teeth so articulated, this balanced articulation is possible *not* because of the direction of the tooth axes, nor because of the teeth being positioned on a spherical surface, but because the tooth guidances are directed toward the articulating center.

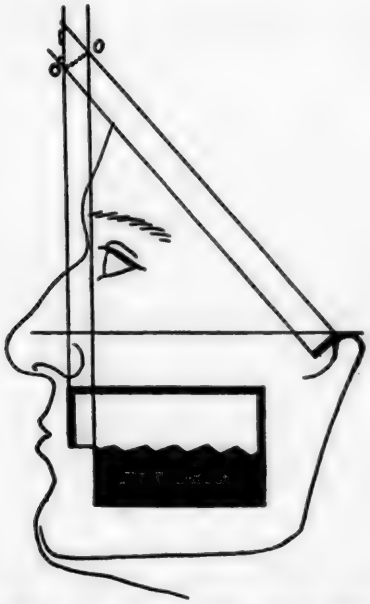


FIG. 11. Straight incisal and condyle guides would connote shifting articulating centers—negligible from a practical standpoint. A locus of instantaneous centers will follow a line from O to O′.

The character of the movement of any articulator is determined by the articulator guides. When the articulator guides are straight, the tooth guidances are also straight in balanced articulation. If this is true, it will indicate the impossibility of accurately grinding occlusal curves in occlusal rims when the incisal and condyle guides do not face one fixed articulating center. The procedure of grinding in curves on wax rims, as believed in by many dentists, becomes increas-

ingly inaccurate as the articulating centers for the various movements become separated.

Gysi has shown that protrusive balance is not necessarily dependent upon the compensating curve nor upon any tooth curve (2). He says: "Für Vorbiss kompensieren also nicht ausschliesslich die Zahnkurve, sondern hauptsächlich die Kompensationsflachen der Molarenhöcker." On the same page, in two drawings (*fig. 13*), he gives a near approach to the idea of a protrusive articulating center as correctly determined by condyle and incisor guidances. Gysi might well have said that the

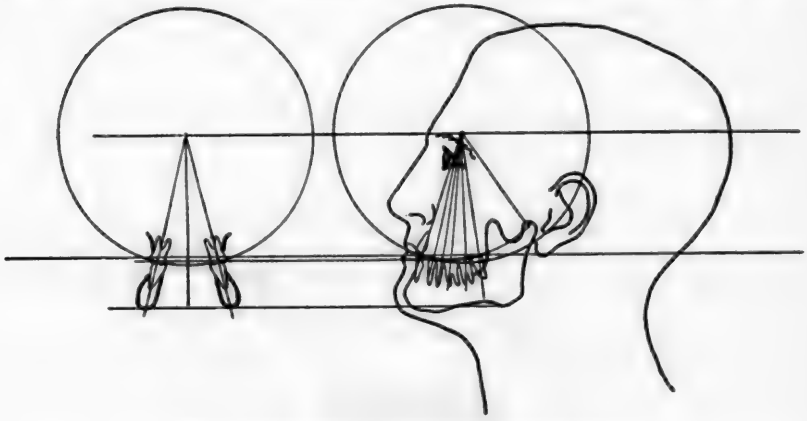


FIG. 12. Illustrations of Monson's "spherical" theory

guidances do the compensating "entirely" without reference to the compensating curve.

It should now be clear that to obtain balanced articulation in the centric-protrusive movement, the conception of an articulating center for this movement makes the solution of the problem both simple and scientific. With the most perplexing problems governing balanced articulations for the centric-protrusive movement thus disposed of, we are now ready to develop, for the other articulating movements, the principle under which we may locate the centers toward which the articulating surfaces face in these movements.

Let us consider the right lateral masticating movement. This movement takes us into the third dimension and is somewhat more complex, but the articulating center is found in the same manner.

It will help us, for instance, in comprehending the movement and in locating the articulating center for a right lateral movement, to consider the right cusp guidances as incisors, the left cusp guidances as last molars, and the left condyle element as the condyle guidances. *Figure 14* represents a view from the posterior aspect as seen on the articulator with the mandibular member in a right lateral relation. *C*—condyle element; *B*—balancing side; *W*—working side; *O*—

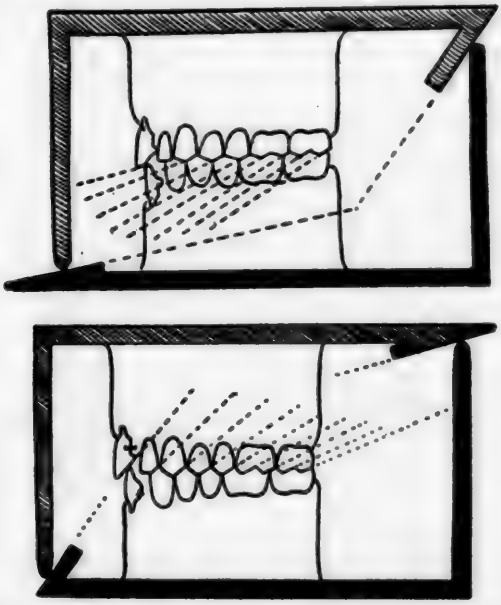


FIG. 13. Gysi's drawings giving a near approach to the idea of a protrusive articulating center as correctly determined by condyle and incisor guidances.

articulating center. The heavy lines indicate guidances. In this projection the movement appears identical with the protrusive movement, in which *C* would represent the condyle element, *B* the molar guidance, and *W* the incisal guidance. With the guiding surfaces straight (not curved as indicated in the figure), the masticating center, *O*, would be a locus.

Virtually the only difference between this movement (*fig. 14*), and the incisive movement first considered (*figs. 1* to *10*), is that this lateral

movement is greatest at points farthest from the right condyle region. The other masticating movements are thus seen to be similar in character to the protrusive movement, with the addition of a pivoting about the working condyle region. The incisal guide of the articulator for the lateral movements serves the same purpose as for the protru-

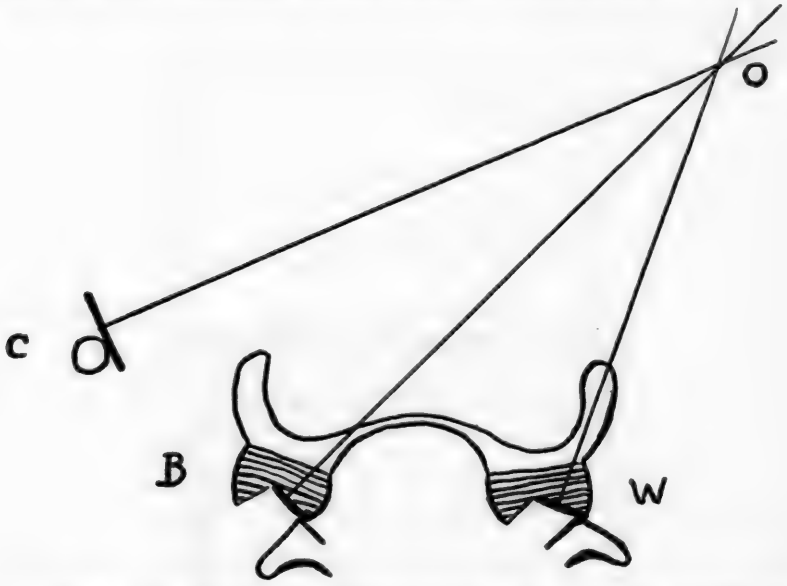


FIG. 14. A view from the posterior aspect as seen on the articulator with the mandibular member in a right lateral relation. *C*—condyle element; *B*—balancing side; *W*—working side; *O*—articulating center. The heavy lines indicate guidances. In this projection the movement appears identical with the protrusive movement, in which *C* would represent the condyle element, *B*, the molar guidance, and *W* the incisal guidance. With the guiding surfaces straight (not curved as indicated in the figure), the masticating center, *O*, would be a locus.

sive movements, even though the contact point travels a slightly curved path with the working condyle region as a center.

The securing of balanced articulation is thus seen to be a matter of visualizing easily localized articulating centers. For instance, in arranging teeth for full denture restoration, one need only view the articulator guides from the buccal aspect in order to visualize an articulating center as a means of correctly tilting the teeth in a sagittal

plane, and then view the articulator from the posterior aspect in order to visualize the right and left articulating centers as a means of correctly tilting the teeth in a frontal plane. A grasp of this simple procedure will rob the subject of balanced articulation of its mystery. It will do more than that: it will reveal the means of deliberately placing these articulating centers at such favorable positions that the forces of mastication will be so directed as to minimize trauma of the tissues that support the denture.

Inasmuch as artificial posterior teeth may be given forms (7) and arrangements differing from the forms and arrangements in nature, we are able to safeguard the integrity of the supporting tissues by first adjusting the incisal guide to locate favorably the articulating centers, and then using tooth forms which can be arranged to cause the cusp guidances to face toward the favorable centers thus located. By visualizing a favorable articulating center for each movement, and by facing the gliding surfaces (tooth guidances) toward these centers, it is possible not only to assure balanced articulation in a definite and satisfactory manner, but also to safeguard the tissues supporting the denture.

Harm has been done through misunderstanding of these principles. Many single teeth have been lost through trauma induced by occlusal restoration out of harmony with the masticating centers (1). Thousands of bridges are lost through lack of appreciation of the necessities regarding this one point alone. Countless ridges in edentulous or partially edentulous mouths are mutilated and destroyed by trauma, which can be traced to improper cusp guidance. Where natural teeth erupt in such a relation that their cusp surfaces are out of harmony with satisfactory masticating centers, the individual often finds his way to the orthodontist or the periodontist and ultimately to the prosthodontist.

In conclusion let me suggest, therefore, that while this problem might seem to have its principal application in the field of denture construction, it may well take its place in the future in the researches of the bridge worker, the orthodontist, and the periodontist.

LITERATURE CITED

(1) FRENCH, FELIX 1924 Cusp trauma. *Journal of the American Dental Association*, xi, p. 792.

(2) GYSI, ALFRED 1915 Das Aufstellung einer ganzen Prothese. *Schweiserischen Vierteljahrsschrift für Zahnheilkunde*, XXV, p. 65.
(3) HANAU, RUDOLPH L. 1926 Articulation defined, analyzed and formulated. *Journal of the American Dental Association*, XIII, p. 1694.
(4) —— 1926 The articulation quint. *Dental Engineering*, II, p. 1.
(5) SEARS, VICTOR H. 1925 Balanced occlusions. *Journal of the American Dental Association*, XII, p. 1448.
(6) —— 1926 Requirements of articulators in dentistry. *Dental Items of Interest*, XLVIII, p. 685.
(7) —— 1928 Channel type posterior tooth forms. *Journal of the American Dental Association*, XV.

MOTTLED ENAMEL

Report of an Examination of an Afflicted District in Italy[1]

FREDERICK S. McKAY, D.D.S.

New York City

The first reference during this investigation to an afflicted district in another country appeared in *Dental Cosmos* for March, 1912, in an article by Dr. W. H. O. McGehee, then of Cincinnati, Ohio, entitled: "An experimental study of the tooth-staining properties of various colored dentifrices." The reference alluded to, as pointed out by Dr. McGehee, occurred in *Dental Cosmos* for March, 1902, and is quoted below in full:

"'Chiaie Teeth.' Dr. J. M. Eager, of the U. S. Marine Hospital Service, reports from Naples, Italy, the frequency of a dental abnormality among the inhabitants of the Italian littoral, and known as 'denti di Chiaie,' this defect having first been described by Prof. Stefano Chiaie. This impairment of the teeth, often not amounting to more than a slight impairment, is of particular interest owing to the fact that Italians who are its subjects frequently present themselves before medical practitioners in the United States. This dental abnormality is an acquired condition, and is due to geological conditions and unsanitary surroundings. In Naples it has been attributed to the water supply, and since this has been changed the disease among infants has greatly diminished.

"'Denti di Chiaie' is really a collective name for various enamel defects. In Pozzuoli, a suburb of Naples, the inhabitants are distinguished from the people of the neighboring places by their black teeth ('denti neri'). This defect is supposed to be caused by the noisome gases from volcanoes. The theory most generally accepted in Italy is that these gases have a selective harmful effect upon enamel formation in early childhood, but that the

[1] Presented at a meeting of the New York Academy of Dentistry, Hotel Commodore, New York City, March 22, 1928, and at a session of the Sixth Annual Meeting of the International Association for Dental Research, Hotel Mayflower, Washington, D. C., March 25–28, 1928.

growth of the other dental tissues is not interfered with. Where the cause is active during the entire period of second dentition, the whole tooth is deprived of enamel and becomes perfectly black. If the growing teeth are exposed for only a short time at the commencement of their formation, only the cutting edges of the upper incisors are affected, and the appearance when the teeth are matured is as if they had been browned by tobacco. The 'denti scritti' (the teeth appearing as if written upon) constitute another form of the Chiaie teeth. These cases are characterized by black markings crossing the incisor teeth in a horizontal direction."

This extract, as it appears above, was included in a series of articles by the writer in collaboration with Dr. G. V. Black, in several issues of the *Dental Cosmos* in 1916, with comments by Dr. Vincenzo Guerini of Naples and further remarks by the writer. So far as the writer is aware this report by Dr. Eager is the first description of this lesion in the literature of dentistry; and, considering that there had been no previous information on the subject, Eager's observations were remarkably accurate. At least there was ample justification for our belief that this Italian condition was identical with that set forth in our own publications.

In pursuing this investigation the writer confesses to an increased fascination in learning of, and particularly in examining, new affected districts or territories, doubtless because of the possibility that in one of them will be found some circumstance or condition that may prove to be the determining factor. At least each new place discovered might furnish evidence that would be confirmatory of that already gathered. All through the years since the writer read Eager's report, he cherished the ambition to make a personal examination of the Italian district referred to in the above quotation. The opportunity to do so presented itself during August, 1927.

The one locality that is particularly mentioned in the quotation above, and in the related comments, is Pozzuoli, a suburb of Naples, located just beyond the point of land that outlines the northern boundary of the Bay of Naples. This was the place which was expected to yield the most important data. The writer was informed, however, from the most reliable sources available, that whereas in former years this enamel lesion was freely produced there, as set forth in Dr. Eager's report, further occurrence had ceased and at

present no cases were being produced. As an explanation it was stated that several years ago a change had been made in the water supply of that community and the water that had been in use at the time of Eager's report, which was derived from a sulphur spring or wells, had been discarded, a new supply having been installed for municipal use from an entirely different source. These statements could not at the time be verified, nor has it been possible since then to do so; but, if the circumstances as related are true, they constitute valuable evidence on the demonstrated water relationship with this enamel defect, and show also the specific effect of a change in the water supply. This evidence will become more valuable when it can be correlated with future results that are being awaited with intense interest, and which will be available in due time, following changes of the water supply for certain communities in our own country. (See the report on Oakley, Idaho, in *Dental Cosmos* for September, 1925.)

It was also stated to the writer that mottled enamel had formerly been produced in Naples, but that production had ceased during the past few years; and I understood that a change in the water supply had also been made there.

I was unable to gain more than hints of other communities in Italy where this lesion existed, and it is a matter of great regret that there were no means by which some of these additional places could be located and examined. In the neighboring city of Resina, however, it was my good fortune to come into direct contact with a district presenting one of the most interesting episodes among the many thus far recorded in this investigation of mottled enamel. A description somewhat in detail is therefore justified.

The city of Naples is located in that great curve of the western shore of Italy, known as the Bay of Naples, which is one of the beauty spots of the world. To the south a few miles and somewhat inland, further away from the shore, stands Vesuvius, with its perpetual column of smoke rising from its crater, in plain sight from Naples. In that immediate vicinity, the land has a gradual slope from the ocean shore up to the base of Vesuvius, and the whole sloping terrain is thickly dotted with small towns and villages. The largest of these is Resina, which is located practically at the foot of Vesuvius, where the tourist changes from the electric railway from Naples to the car that ascends

to the crater. It was my good fortune to secure as my guide an employee of the Thos. N. Cook agency, who was not only a native of Resina, hence thoroughly familiar with the district and its people, but himself afflicted with a thoroughly typical case of mottled enamel—one of those cases in which there was an extreme manifestation of the associated condition so often described as the "brown stain," except that the teeth were almost black.

These circumstances gave my guide a most personal interest in our examination of Resina, and before starting he imparted the astonishing information that within the city proper we would find the defective enamel only in *adult* individuals, and that the present generation of children would be found to be unaffected. Before we had gone very far I found that my guide was right, for he led me up alleys, into back yards and inner courts, and even into houses where he assumed all the prerogatives of a native son in personally opening the mouths and drawing back the lips, literally compelling the proletariat to show me their teeth, in the meantime keeping up a rapid-fire comment in Italian, *prestissimo*, to intimidate the unwilling. We were usually surrounded during these ceremonies by a motley group of women and children whose mouths were sympathetically half opened, wondering what it was all about. More than this, my guide in more than one instance had to assure the suspicious householders that I was not an agent of Mussolini, sent to impose some new form of taxation, possibly upon those who were revelling in the luxury of mottled and stained teeth. But it was a fact that I was shown case after case of adult natives of this city who presented teeth typically marked, while we were not able to find one single native child who had anything but "normal" enamel. I was amazed at the acuteness of the observations of my guide prior to this tour of examination.

Upon inquiring into the water supply I received the further astonishing information that, until a few years ago, when water from the slopes of the hills adjacent to Vesuvius had been piped into the city, these adult people had been dependent upon water from wells located in the court yards and used by several families. I saw some of these abandoned wells, which were of an inside diameter of about seven or eight feet, and an average depth of about fifty feet. Water was of course still standing in them, but that they were not being used was

evidenced by the accumulation of rubbish and debris. The municipal installation was not like our own, although I saw several houses in which there were pipes and faucets, but a large proportion of the population got their household supply by going with pails and pitchers to open spigots in the streets.

The important fact, then, is the observation that these adult native cases grew their enamel while the well-water was being used, but the present generation, which is free from the disorder, grew their enamel under the piped-in water. The significance of this observation must be evident to those who compare this finding with the many similar instances described in our previous articles on this subject.

In order to have a complete understanding of the conditions of life in a community like Resina, it should be pointed out that often, if not as a rule, generations of these families, from birth, live in the same dwelling houses. Owing to the most stringent economic conditions, their migrations are exceedingly limited, and they seldom travel far afield. Therefore, such an influence as this water relation is practically constant. Their habits of life, including diet, also remain practically unchanged from one generation to another.

My guide understood, then, that I wanted to see some children who were afflicted with this enamel defect, and so we took our way into the outlying district of the city. The streets of Resina are extremely narrow and enclosed by high walls of stone. The footway was inches deep with dust, ground to an impalpable fineness. There were no shade trees, and an August sun was in the skies. It had not rained for about five or six months, and the heat was an inferno such as I have seldom experienced.

In this outlying district our method of examination was a house to to house canvas, the families being personally known to my guide. These people were engaged in farming small plots of land. Because of conditions similar to those obtaining within the city of Resina, as described above, not only had the children been born and reared on these small plots where they are now living, but in the immediate vicinity the parents also. Precisely the same character of data was found in going from one house to another. Without exception these children and their parents presented illustrations of this defect of the enamel, including the brown discoloration, which were as typical as

any recorded throughout the progress of this investigation. It is of additional interest to point out that the appearance of the enamel here follows every phase and characteristic of the lesion existing in all of the afflicted districts heretofore described and illustrated. One of these cases is illustrated in *fig. 1.*

So clearly has the water relationship of this defect been established that it is necessary to give a general description of the district examined, and to point out the peculiarities of the water supply. The modern city of Resina was built about one thousand years ago, and is located directly over the ancient city of Herculaneum, which was "a

FIG. 1. Mottled enamel. Patient resident in Resina, Italy

victim of the same eruption of Vesuvius that destroyed Pompeii in A. D. 79," Pompeii having been but a few miles further to the south. "But whereas Pompeii was buried toward the end of the eruption by a shower of ashes, Herculaneum was overwhelmed at the beginning by a mass of mud and lava, which gave the inhabitants barely time to escape alive but not to remove their valuables. After the eruption the Pompeiians dug through the ashes covering their houses and recovered almost everything of value. Moreover, in subsequent centuries other persons did likewise and looted Pompeii of everything that took their fancy, until little remained when systematic excavation began. At Herculaneum on the other hand, the covering of

mud and lava was so thick that it lay absolutely undisturbed for nearly seventeen centuries." (Ybarra.)

The late Prof. Waldstein, in his book on "Herculaneum, Past, Present and Future," says: "In the lower portions [of the city], where the covering is not so thick, there is evidence that attempts were made to excavate and save what was buried. In later times also the workers in the field and those who dug down for wells as in 1709 (such diggings led to the finds which initiated the first excavations) were casually and sporadically led to seek for treasure in the buried remains." Waldstein, whom we are proud to claim as a native American, although a member of the Faculty of Cambridge University in England, apparently realized beyond any others the immense value to archaeology that would accrue through the excavation of this buried city (which he points out far exceeded in culture the neighboring city of Pompeii) in the recovery of the wealth of art and literary objects that have lain there buried for almost two thousand years, and he devoted his life to efforts to induce other governments to coöperate with that of Italy in the gigantic task of excavation. At present there is very little available to the tourist beyond a small area excavated within comparatively recent years, and that amazing theatre buried deep under the present street level of Resina, partly excavated, which is of such absorbing interest to visitors. One writer states that it was the digging of a well through the lava that led to the discovery of this ruin. Waldstein says that "of all the buildings discovered between 1738 and 1766 only the theatre is accessible. The reason for this lies partly in the situation of the ancient city under the houses of the modern Resina, which presumably makes it forever impossible to lay it bare in the manner of Pompeii."

Of the general history of the eruptions of Vesuvius, Waldstein has the following to say:

"Of the subsequent history of Vesuvius a brief sketch must here suffice. The next recorded outbreak occurred in 203, and lasted seven days; it was audible at Capua. Among the most noticeable of later eruptions are the following: First, those of 306 and 471 are both said to have caused alarm as far as Constantinople; and the ashes from the latter eruption (which lasted till 474) are said to have reached that city. The first recorded lava-streams flowed in 513, and more appeared twenty years later. In the

great eruption of 1306–1308 lava burst from the sides of the mountain as well as from the crater.

"From 1500, or it may be even earlier, nothing is recorded of Vesuvius until the appalling outburst of 1631. From 1631 until the present day it has only twice rested for more than thirty years at a stretch, and there have been as many as twenty-five distinct eruptions, one of which lasted for twenty and one for sixteen years. We have no space to give details of all

FIG. 2. A well outside of Resina, Italy

these; it will be enough for our present purpose to point out that the lava of 1631 seems to have flowed in two streams each side of the site of Herculaneum, at some distance from it, which it barely touched; and that no subsequent eruption of lava has affected it at all."

Inasmuch as the wells within the city of Resina have been abandoned as sources of water supply, our interest in them is related only to their past, except that it is significant for us to notice that they had been sunk into the ancient lava flow, and that the water coming into them had seeped through extensive deposits of the lava. Of intense interest, however, are the conditions of the water supply for these

small householder's plots outside of Resina, upon which, to our knowledge, the typical enamel lesion has been produced during the past two generations, and is still being produced. On each of these householder's plots I found a well of much the same dimensions as those formerly in use within Resina. The water was used not only for the household supply, but also for irrigating the garden patches. The method of raising the water was by means of a crude windlass actuating a system of metal buckets on an endless chain, the windlass being turned by a donkey hitched to a long horizontal wooden pole or arm and traversing a circle of ten-foot radius as illustrated by the accompanying photograph (*fig. 2*). My informant stated that some of these wells had been sunk as long as three hundred to five hundred years ago, and had been in constant use ever since. Like the wells in Resina, they had been sunk into the underlying lava, and the water in them came from seepage through the lava. In some of them I could plainly hear water trickling in from this underground source. I was told, also, that it was about thirty feet down to the top of the lava flow. This water was clear and cold, and generally tasteless.

It is again to be emphasized that the persons examined, parents as well as children, had actually been born in these same houses in which we found them, and had never lived anywhere else. When I say "parents" it is to be understood that actually both parents in some cases had been born in the same houses, some of which were occupied by more than one family. In other instances one of the parents had been born in a given house while the other perhaps came from a dwelling near by, but in which the water-supply conditions were duplicated. The fact is, then, that *not one individual who had used water from these wells during the enamel growing period had escaped the enamel defect.* On the contrary, I can cite one instance in which the father and children having been born and raised on the home plot were afflicted, yet the mother, who was born and raised outside this district, on the slopes of Vesuvius, had normal enamel. I saw also a boy of ten, now living in this district but who had been raised on the city water in Resina, whose enamel was normal.

These conditions, as related above, constitute another chapter pointing conclusively to the water used during the years of enamel growth as the one etiological factor in the occurrence of this lesion

within sharply defined geographical limits. It should be noted also that Resina is another of the communities in which a change in the water supply has stopped the production of this defect. I pointed out, earlier in this article, unconfirmed evidence on the same point at Pozzuoli and in Naples. I was assured by my guide that a duplicate of the conditions just described could be found by extending our examination into adjacent districts.

From correspondence prior to 1918, with Prof. John E. Grevers, then of the University of Utrecht Dental School, whose views as held at that time were included in an article contributed by me in the

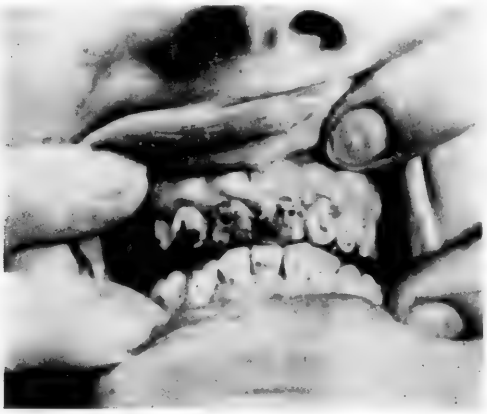


FIG. 3. Mottled enamel. Patient born in Rotterdam, Holland

Journal of the National Dental Association for July 1918, it was evident that this same lesion occurred in certain parts of Holland. An attempt to verify this by personal observation was made during August, 1927, but lack of time, and of facilities for obtaining definite information as to the location of the suspected districts, made my efforts of no avail.

Some six years ago through the interest of Drs. Hyatt and Hunter, of the Metropolitan Life Insurance Dental Clinic, I was able to observe a case—a young woman, a native of Rotterdam, Holland—whose appearance at that time is represented by *fig. 3*. This case-

and-locality report is included as a supplement to Grevers' observations.

Fig. 4 shows illustrations of teeth of the molar and bicuspid series secured in Holland and sent to me by Dr. Grevers a few years ago, when he was active in the teaching staff of the University of Utrecht. The enamel shows the typical dead white and pitted appearance. It is of further interest to note that many of the illustrations in the monumental article on mottled enamel by Dr. J. Leon Williams, in the *Journal of Dental Research* for September, 1923, were made from this same collection.

During a visit to Dr. Grevers in Holland in August, 1927, he reported to me in conversation, and since then in writing, his observation of this lesion in its typical form among the Arabs of Algeria and Tunisia, during his travels in those countries in 1927. Confirmatory

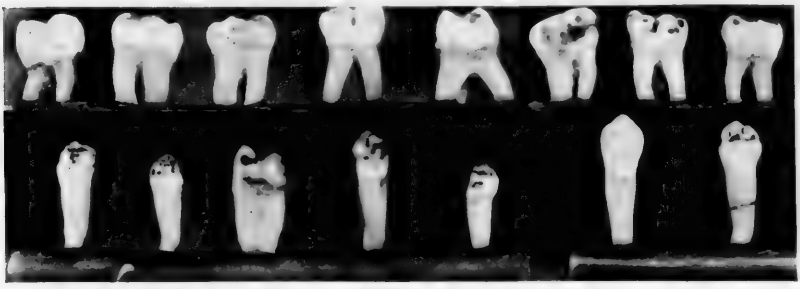


FIG. 4. Mottled enamel. Teeth obtained in Holland by Grevers

of this evidence, *fig. 5* shows a desert dweller, this illustration having appeared in the *National Geographic Magazine* for December 1927, in an article by Owen Maynard Williams. Dr. Grevers also offers the interesting testimony that, in the Museum at Leyden, Holland, there is a skull of an orang outang, shot in Borneo, in which the teeth have mottled enamel.

In reviewing again the findings at Resina, in reference to the source of the associated water, it is pertinent to note that this is the first recorded instance in which the water has been derived from or associated with a definite volcanic origin. It seems important to point

out, in view of a possible relationship, the seeming similarity, perhaps obscure at the present time, between this water flowing over and through the lava deposit under Resina, which had been belched from the heated interior of the earth, and those deep artesian waters so

FIG. 5. Mottled enamel in a "Sheik of the Desert." (Copyright: National Geographic Society. Reproduced, by special permission, from the National Geographic Magazine.)

often associated with this enamel defect in districts previously reported. A similar comparison could be made with the hot-spring waters at Oakley, Idaho, and at other known localities to be reported later, which, it is certain, come from deep within the crust of the earth.

Neither is it to be overlooked that, in many of the endemic districts previously described, the waters were of surface origin and bore no relation to deeper strata. While at first glance this fact is possibly confusing, it shows clearly that the next important step is to determine the chemical peculiarity common to these waters regardless of the sources from which they are derived.

2 East 54th Street

STUDIES IN THE CAUSES OF DENTAL ANOMALIES[1]

W. G. DOWNS, JR., M.A., D.D.S.

Department of Anatomy, Indiana University, Bloomington, Indiana

In the studies basic to this paper, a large number of cases was included from the Southern Indiana Hospital for the Insane at Evansville, the Indiana School for Feeble-Minded Youth at Fort Wayne, and the private practices of the author and his associates. Careful records were kept of both the dental and systemic findings for all of the patients, and, where possible, records were obtained of the families of these patients. In the case of the School for the Feeble-Minded, in particular, these records were extremely complete and accurate, some of them extending back to the date of organization of the present institution—nearly thirty years ago; and many of them covering a period of ten years. A careful review of the literature, in its dental, endocrine and genetic phases, was made. Experiments were made with feeding and injecting dogs with the extracts of both the anterior and posterior lobes of the pituitary gland. Finally, experiments in feeding the extracts of both lobes of the pituitary gland are still in progess on a group of selected cases in the Indiana School for Feeble-Minded Youth.

Six hundred and forty-seven clinical cases were studied. These were divided in accord with the endocrine diagnoses, as follows: cretins, mongols, dwarfs, giants, acromegalics, polyglandular dyscrasias, hermaphrodites, border-line cases, adiposo-genitalias, diplopias, goitres, microcephalics, macrocephalics, virilisms, infantilisms, myxoedemas and normals. The same group of cases was then divided according to the dental anomalies found, as follows: missing laterals, other teeth congenitally missing, peg-shaped laterals, super-numeraries, spaced uppers, bunched lowers, prognathisms,

[1] Reprinted, with the approval of the author and the editor, from *Genetics*, 1927, xii, pp. 570–80 (November).

mesognathisms, and normals. The two classifications were then cross-consolidated to form *Table 1.*

TABLE 1

Endocrine data on the occurrence of dental anomalies

GLANDULAR DYSCRASIAS	NORMALS (APPROXIMATELY)	MISSING LATERALS	OTHERS MISSING	PEG-SHAPED LATERALS	SUPER-NUMERARIES	SPACED UPPERS	CROWDED LOWERS	PROGNATHISM	MESOGNATHISM	TOTALS
Cretins	17	4	0	2	0	1	2	2	1	29
Mongols	19	4	3	1	0	3	4	1	2	37
Dwarfs	5	1	1	1	2	3	3	2	1	19
Giants	5	0	1	1	2	5	3	5	1	22
Acromegalics	11	1	0	1	1	4	2	4	1	25
Polyglandulars	20	3	3	1	2	7	8	4	2	50
Hermaphrodites	4	1	0	1	0	1	2	0	1	10
Borderlines	41	4	3	2	2	12	17	7	4	92
Adiposo-genitalias	3	1	1	1	0	2	2	0	1	11
Diplopias	6	0	0	1	1	2	3	0	1	14
Goitres	16	1	2	1	2	2	5	1	0	30
Microcephalics	1	1	0	0	0	0	1	0	1	4
Macrocephalics	2	0	0	0	1	1	0	1	0	5
Infantilisms	2	1	1	0	0	0	0	0	1	5
Virilisms	3	0	0	1	1	0	2	1	0	8
Myxoedemas	3	1	2	0	1	3	0	3	1	14
Normals	229	4	1	3	1	7	18	6	2	271
Totals	387	27	18	17	16	53	71	37	20	647

Explanation.—Figures above refer to cases studied, the horizontal ones being the endocrine groups, divided vertically to demonstrate how these in turn fall into the groups of dental anomalies. Cases were assigned to definite endocrine groups only if the clinical picture presented was clear-cut. If there was any grave doubt as to the proper grouping, they were classed as "borderline" or "polyglandular" cases. It was not attempted to group the various kinds of "goitre" cases. Very probably all of the cases listed as "giants" are not true pathological giants, nor are all of those classed as hermaphrodites true "mixed" sex cases. It may be readily seen that a definite diagnosis in such cases would require autopsy or at least operative procedure. Dentally, cases were only classed as "spaced," "bunched," "prognathic," etc., if it could be reasonably assured that the condition was not due to operative or traumatic causes. On the whole, it is felt that the above classification is as accurate as available clinical diagnostic methods could make it.

The purpose of this tabulation was to determine if certain types of dental anomalies occurred regularly in definite types of endocrine

dyscrasias. It was felt that in order to determine this occurrence, either a certain type of dental anomaly must be found most frequently in cases of a certain type of endocrine dyscrasia or that a majority of the cases of a definite dyscrasia must likewise present a particular type of anomaly. Such was not found to be the case.

Referring to *Table 1*, it will be seen that in no case did there appear to be any typical coincidence of endocrine dyscrasia and dental anomaly. Missing laterals, peg-shaped laterals, crowded lower anteriors, cases of prognathism and the other anomalies all occurred with about equal frequency in the various endocrine dyscrasia types. It was found, however, that close to 50 percent of all of the cases of endocrine dyscrasias likewise had dental anomalies of one or the other types, while the larger group of normal cases showed only about 17 percent of dental anomalies. Thus, while it was evident that dental anomalies are more frequent in endocrine cases, no conclusion of a positive nature could be drawn regarding the regularity of occurrence of dental anomalies of a definite type in specific endocrine dyscrasias. It would, then, be difficult to understand how the appearance of a dental anomaly could be considered as pathognomonic of a particular type of endocrine dyscrasia.

While the literature in the endocrine, dental, and genetic fields bearing on the causation of dental anomalies is relatively scarce, its review was nevertheless productive of the finding of widely variant results and views. On the whole, its trend was toward a particular endocrine causation of specific dental abnormalities. Kaplan (1917), Wheelon (1925), Engelbach and Tierney (1922), Cedercreutz (1925), Ward (1925), Timme (1918), Petzel (1922), Kranz (1912), Graves (1904), and Howard (1926) seemed to lean in varying degrees toward this view. Howard (1926) reports over six hundred cases studied, with results not coinciding with those included in this study. This was especially true in regard to the incidence of missing teeth in mongols. Inasmuch as it is extremely difficult to obtain accurate records of previous dental operations in patients of this type, it is at least possible that the findings in some of his cases were due to earlier extractions. In most of the cases reported in the literature, it is felt that there has not been a sufficiently large series of cases examined

from this angle, or that the cases have not been carefully enough controlled to make the findings valid.

On the other hand, some workers have cited about an equal number and type of cases supporting the genetic origin of dental anomalies, rather than the endocrine. Among these latter are Lucas (1888), Keith (1919), Beadle (1926), Pitts (1922), Thadani (1921), and Hopson (1920), while Castle (1916) is convinced that factors influencing dental development, like those concerned with the length and color of hair, are undoubtedly genetic, and Maud Slye (1926) asserts that all regular types of variations from normal in any of the organs have a genetic origin.

In the feeding experiments, five litters of four puppies each were used, the average age for the entire series at the beginning of the experiments being four weeks, none being over six weeks of age. The animals were all about the same size, averaging about 2 kg. in weight at the beginning of the experiments. No regard was paid to sex in these experiments.[2] In each litter, one dog was fed the extract of the anterior lobe, one that of the posterior lobe, one that of the whole gland, and one, the control animal, was fed a normal diet only. Armour's tablets made from the dried ox-gland were used throughout. The dosage was computed so as to be approximately proportionate to the maximum dosage for a human of average weight, which was, in the case of the anterior lobe extract, .035 gm. of the posterior lobe extract, .0016 gm., and of the whole gland extract, .035 gm. The extract was administered regularly three times a day; each animal was given 4 gm. of codliver oil (Mead-Johnson Company's) once a day, to offset any possibility of rickets; and all of the animals were wormed, when the need for it became evident.

Beginning four weeks from the start of the experiment, entire litters were killed at intervals of four weeks. Tissues were fixed in 10 percent formalin, decalcified in 5 percent HCl in 67 percent ethyl alcohol, and paraffin sections were made through the upper and lower maxillae at such an angle as to include the temporary teeth and the

[2] The animals used throughout were mongrels, so that although the blood was the same in all of those within the litter, the litters were not known to be homozygous for any character.

developing permanent ones.[3] These sections were then stained with chloral hematoxylin and counterstained with eosin. The sections were carefully studied and compared, but no definite variations in placement, form, or texture could be noted in either temporary or developing permanent teeth.

For the injection experiments, dogs likewise were used. The age of the animals was the same as that of those in the preceding experiments. Six litters of three puppies each were used. In each litter, during the first six weeks, one dog was injected with .18 cc. of antuitrin

TABLE 2

Genetic data on the occurrence of dental anomalies

DENTAL ANOMALIES	FAMILY HISTORIES OBTAINED		FAMILY HISTORIES NOT OBTAINABLE	TOTALS OF EACH TYPE
	Histories positive	Histories negative		
Missing laterals	9	0	2	11
Others missing	2	0	0	2
Peg-shaped laterals	2	1	2	5
Supernumeraries	2	1	3	6
Spaced uppers	10	1	5	16
Crowded lowers	9	1	8	18
Prognathism	3	1	1	5
Mesognathism	3	1	1	5
Totals	40	6	22	68

Explanation.—While the above figures refer to individuals studied, columns 1 and 2 likewise represent families, as where the history was obtained, the entire family was charted and studied. The series is divided into the different types of anomalies, only as a matter of secondary interest, to demonstrate the proportions found.

(Parke, Davis and Co.) twice daily, one dog received .18 cc. of pituitrin (Parke, Davis and Co.) twice daily, while one, the control animal, received a like amount of sterile water. Although no apparent untoward local or systemic effects were observed from this rather excessive dosage, six weeks after the beginning of the experiment, it was felt better to use a more nearly proportionate dosage and the amount was reduced to .06 cc. twice daily, in each case.

[3] It was felt to be better to study the effect on the permanent dentition prior to eruption, as decalcification of an erupted tooth destroys the enamel completely, whereas if decalcified in its crypt, all of the structures remain intact.

As in the preceding series, litters were killed at intervals of four weeks from the beginning of the experiments, except in the case of the last litter, in which the death, from spasms, of the animal receiving anterior lobe extract made it necessary to kill the remaining members of the litter two weeks earlier than had been contemplated. Sections were made of the maxillae of all of these animals and prepared in the same manner as in the preceding series.

While some very interesting and surprising systemic results were obtained, which will be discussed in a later paper, no definite changes in the placement, form, or texture of the temporary or the unerupted permanent teeth could be demonstrated.

In none of the cases, in either the feeding or injection experiments, were there any apparent histological differences in the number, form, size, or nuclei of the ameloblasts; the size, arrangement, or form of the forming enamel rods; the number, size, arrangement, or form of the dentinal tubules; or the number, size, form, or nuclei of the odontoblasts, or of the various pulpal cells. Neither was there any apparent interference in the form, size, or placement of the erupted temporary teeth, or of the unerupted permanent teeth. In short, neither type of medication, simulating in some degree over-secretions of the gland, seemed to influence to any extent the teeth of these animals.

In seven months of administration of the pituitary extracts, per orum, to the patient of the Indiana School for Feeble-Minded Youth, no evidence of any effect on the dental mechanism has been noted. Considering the length of time required for the formation of the human dentition, no results could be expected in such a period. These experiments are still in progress.

From the above-detailed series of experimental studies, it is felt that certain tentative conclusions may be warranted. While the endocrines may, and judging from the literature, probably do, play an important part in calcium metabolism, they do not apparently act in such a way as to cause regular types of dental anomalies (*Table 1*).

In the cases studied clinically, it was noted how frequently the anomalies were found recurring in families. For this reason, a study was made of the possibility of the occurrence of a genetic factor in the production of dental anomalies. Seventy-one patients showing very typical anomalies were selected for this study, and the group was

divided in accordance with the type of anomalies presented. Of these seventy-one cases, forty-seven fairly complete family dental records could be obtained.

In twenty-four cases no family dental record was obtainable. Of the forty-seven cases in which a fairly complete family record was obtained, five showed no dental anomaly in other members of the family, while forty-two did show one or more other anomalous cases of a similar character in the family. The forty-two families showing positive results were then studied to determine what proportion of anomalies was found in each generation (*Table 3*).

TABLE 3

Genetic data on the occurrence of dental anomalies

	TOTAL NUMBER INDIVIDUALS PER GENERATION	TOTAL NUMBER ANOMALOUS INDIVIDUALS PER GENERATION	TOTAL NUMBER NORMAL INDIVIDUALS PER GENERATION	RATIO ANOMALOUS INDIVIDUALS TO NORMAL INDIVIDUALS
Parental generation	84	39	45	3.4:4
Filial 1 generation	177	21	156	0.5:4
Filial 2 generation	382	107	275	1.5:4
Filial 3 generation	219	64	155	1.6:4
Filial 4 generation	16	8	8	4.0:4

Explanation.—This table was made by taking the entire number of cases of each type from the totals in each generation of the forty-two positive cases for which histories were obtainable, from column 1 of *Table 2*. Thus, the ratios are cross-sections of each generation of the entire forty-two families. There is a regularity which bespeaks adherence to some genetic system.

It was felt that the constant recurrence of a certain type of anomaly within a given family, offered of itself considerable evidence of a genetic causative factor. If, however, in addition to this, some regular formulae or ratios, describing these occurrences could be found, it would certainly lend strength to the original evidence offered. In determining these ratios, the first generation obtainable in each family was classed as the Parental, the next as the Filial 1, etc. The total numbers of individuals through each complete generation of the entire forty-two families was then divided into those showing a familial anomaly and those not showing it, classed as normals. The results of this tabulation (*Table 3*) showed eighty-four individuals in the

Parental generation, of which thirty-nine had the anomaly which was found appearing in their respective families, while forty-five showed no evidence of it. This gave, in the Parental generation, a ratio of 3.4:4.0. In the next, or Filial 1 generation, of a total of one hundred and seventy-seven individuals, twenty-one exhibited the familial anomaly, while one hundred and fifty-six did not. The ratio yielded in this case, then, was 0.5:4.0. The Filial 2 generation, having

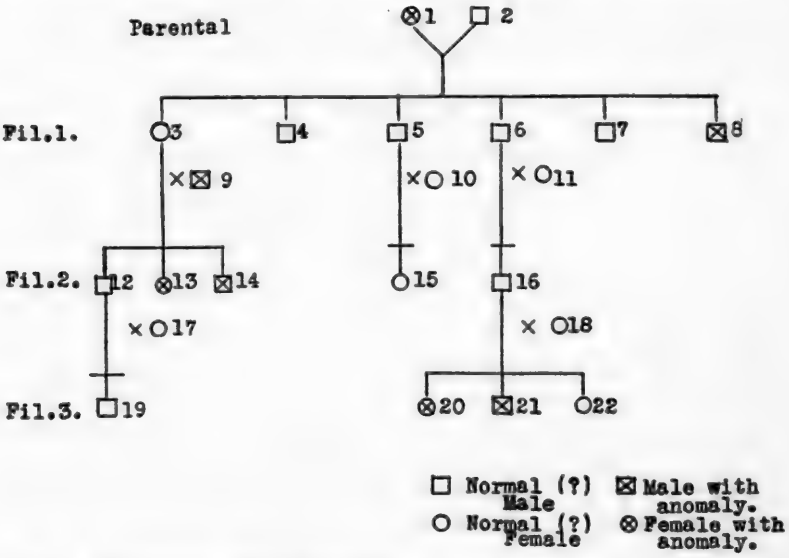


FIG. 1. Explanation.—Figures containing an × (⊗ 9, etc.) represent individuals having the anomaly—in this case, a very distinctive type of marked prognathism. Plain figures merely do not show it, or at least not characteristically. It is probable that those who do show it are homozygous recessives, but it is difficult to determine the genetic character of those who do not show it.

a total of three hundred and eighty-two individuals, had one hundred and seven with their respective familial anomalies and two hundred and seventy-five without it. The ratio in this case, then, was 1.5:4.0. A total of two hundred and nineteen individuals of the Filial 3 generation disclosed sixty-four having the anomaly as against one hundred and fifty-five not having it, showing a slightly augmented ratio of 1.6:4.0. It was only possible to obtain Filial 4 family records in five

cases, which yielded a total of sixteen individuals of this generation, of which exactly one-half showed the family anomaly and one-half did not, resulting in a balanced ratio of 1.0:1.0.

Where positively complete family dental records were obtainable, in a few instances the families were genetically charted as in *figs. 1* and *2*.

Hypothetical genetic characters were given to the various individuals in the family, temporary charts were constructed, were corrected, new hypotheses were attempted and again corrected, until apparently

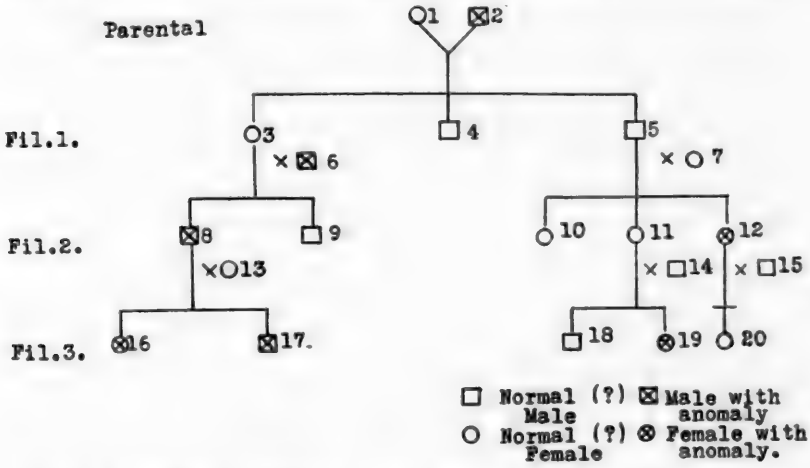


FIG. 2. Explanation.—Explanation of *fig. 1* likewise applies to this, except that the anomaly in this case consists of missing laterals. No individual in this chart, including the collateral lines has laterals sufficiently large and well-formed to be considered fully normal, which, of course, makes even a tentative interpretation more difficult.

probable schema were obtained. *Figs. 1* and *2* show the results in two of these cases. In one especially noticeable case, which is in the same family as that shown in *fig. 1*, the anomalous individuals showed such exactly similar conditions in the different generations that one case was selected from each living generation, casts made, and photographs of these casts were taken (*figs. 3* to *5*).

While the results of the genetic tabulations do not yield Mendelian ratios, it will be remembered that in dealing with human genetics, so many factors enter into a given result that the probable error is

FIG. 3. Cast of the mouth of individual 8 from *fig. 1* (Generation F1, Age 53)

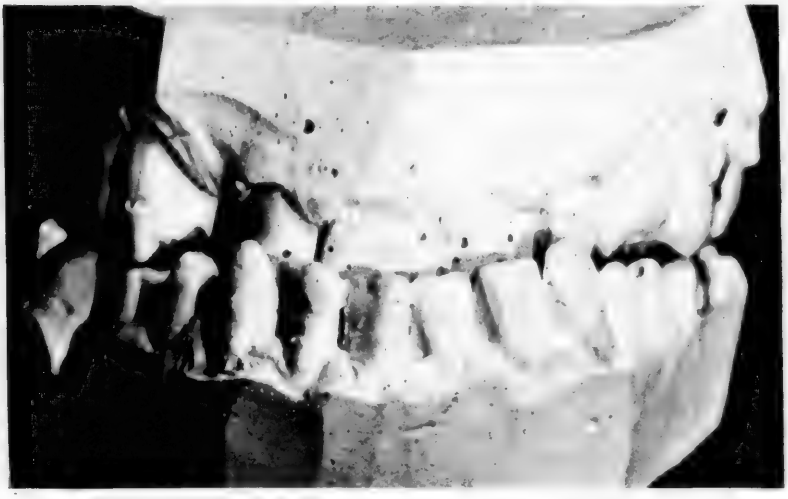


FIG. 4. Cast of the mouth of individual 14 from *fig. 1* (Generation F2, Age 39)

enormous. Considering this, there is a regularity in the ratios in the sequence shown, which bespeaks adherence to some sort of a genetic

system. It is probable, but undetermined, that the dental anomalies are simple recessive characters (Castle, 1916). In any event, the appearance of these anomalies within given families is so regular that the hereditary influence seems more than likely.

In summary, the conclusions from the above-detailed series of investigations are fairly obvious. Although it is possible that dental anomalies may sometimes appear as the result of endocrine dyscrasias, just as may be the case with vitamine deficiencies or other develop-

FIG. 5. Cast of the mouth of individual 20 from *fig. 1* (Generation F3, Age 6—temporary teeth). Note the regularity in type of these three cases (*figs. 3, 4, and 5*). Other individuals from this family show, as nearly as is possible, an identical condition.

mental interference, it is very unlikely that there is any regularity about such appearance.

Dental anomalies probably cannot be considered as pathognomonic of any definite type of endocrine dyscrasia.

It would seem to be fairly certain that anomalies in dentition are recurrent in families as the result of the operation of genetic or hereditary factors.

I am greatly indebted for the assistance of Dr. J. A. Badertscher, of the Department of Anatomy of the Indiana University School of

Medicine, for the oversight of my work; to Dr. L. P. Harshmann, of the Indiana School for Feeble-Minded Youth, for extending the facilities of that institution and for much valuable assistance in diagnosing and handling cases; and to Dr. W. G. Downs, Sr., of Evansville, and Drs. Beale, Rawles, Hilgemann and Duemling, of Ft. Wayne, Indiana, for placing at my disposal a great deal of valuable clinical and bibliographic material.

LITERATURE CITED

BANDLER, S. W. 1920 The endocrines. 58 pp. Philadelphia: W. B. Saunders Co.

BEADLE, O. A. 1926 An inherited anomaly of dentition. *Jour. Genetics* **17:** 72–89.

BELL, W. BLAIR 1918 The pituitary. 94 pp. New York: Wm. Wood & Co.

CASTLE, W. E. 1916 Genetics and eugenics. 241 pp. Cambridge: Harvard University Press.

CEDERCREUTZ, A. 1925 Sind innersekretorische Störungen auf kongenital-luetischer Grundlage als Ursache der hutchinsonischer Triad? *Münch. Med. Woch.* **72:** 1960–1962.

CUSHING, H. C. 1912 The pituitary body and its disorders. 331 pp. Philadelphia: J. B. Lippincott and Co.

ENGELBACH, W. 1920 Classification of disorders of the hypophysis. *Endocrinology* **4:** 347–365.

ENGELBACH, W., AND TIERNEY, J. 1922 Tice's practice of medicine. Vol. **8: 5:** 337–738.

GARRISON, F. H. 1922 Endocrinology and metabolism. Vol. **1:** 45–80. New York: D. Appleton and Co.

GRAVES, W. W. 1904 Ueber Lückenbildung zwischen den einzelnen zähnen; ein fruhdiagnostiche, und bisher wenig bekannter zeichen der Akromegalie. *Monat. f. Psych. u. Neur.* **16:** 18–48.

HALSEY, J. T. 1922 Endocrinology and metabolism. Vol. **1:** 81–152. New York: D. Appleton and Co.

HOPSON, M. F. 1920 Hemihyperplasia of face, jaws, and teeth. *Proc. Roy. Soc. Med. Sect. Odont.* Pt. III, **13:** 67–70.

—— 1921 Complete absence of deciduous and permanent teeth. *Proc. Roy. Soc. Med. Sect. Odont.* Pt. III, **14:** 23–26.

HOSKINS, R. G. 1922 Endocrinology and metabolism. Vol. **2:** 919–930. New York: D. Appleton and Co.

HOWARD, C. C. 1926 A study of jaw and arch development considered with the normal and abnormal skeleton. *Jour. Ortho. Oral Surg. and Rad.* **12:** 3–16.

KAPLAN, D. M. 1917 An endocrine interpretation of the dental apparatus. *Endocrinology* **1:** 208–221.

KEITH, A. 1919 The differentiation of mankind into racial types. *Lancet* **2:** 552–556.

KRANZ, P. 1912 Schilddruse und Zähne. *Deut. Monat. f. Zahnheil.* **30:** 1–35.

LEWIS, DEAN 1922 Endocrinology and metabolism. Vol. **1:** 721–736. New York: D. Appleton and Co.

LUCAS, H. C. 1888 On the congenital absence of an upper lateral incisor tooth as a forerunner of a hair-lip and cleft-palate. *Trans. Clin. Soc.* **21:** 64–66.

NOVAK, E. 1922 Endocrinology and metabolism. Vol. 1: 153–160. New York: D. Appleton and Co.

PETZEL, W. 1922 Die endrokrinen Drüsen in ihrer Beziehung zu Zahn und Kieferanomalien. *Deut. Med. Woch.* **48**: 231.

PITTS, A. T. 1921 Some cases of hypoplasia of deciduous dentition. *Proc. Roy. Soc. Med. Sect. Odont.* Pt. III, **14**: 28–32.

—— 1923 Absence of the permanent teeth with normal absorption of their deciduous predecessors. *Proc. Roy. Soc. Med. Sect. Odont.* Pt. III, **14**: 33.

POTTENGER, F. M. 1922 Endocrinology and metabolism. Vol. 1: 161–180. New York: D. Appleton and Co.

SHARP, J. G. 1916 Atrophy of the thyroid gland with hypertrophy of the pituitary gland. *Clin. Jour.* **45**: 290–291.

SIMONDS, J. P. 1922 Endocrinology and metabolism. Vol. 1: 767–804. New York: D. Appleton and Co.

SLYE, MAUD 1926 The hereditary character of cancer. *Jour. of Canc. Res.* **10**: 15–49.

THADANI, K. J. 1921 A toothless type of man; The Bhuddas of India; A case of sex-linked inheritance. *Jour. Heredity* **12**: 87–88.

TIMME, W. 1918 A new pluriglandular compensatory syndrome. *Endocrinology* **2**: 209–240.

UHLENHUTH, E. 1921 Experimental gigantism produced by feeding pituitary gland. *Proc. Soc. Exp. Biol. and Med.* **18**: 11–14.

—— 1921 Experimental production of gigantism by feeding the anterior lobe of the hypophysis. *Jour. Gen. Physiol.* **3**: 347–365.

WARD, W. G. 1925 The relation of the endocrine glands to the teeth in rickets. *Med. Jour. and Rec.* **122**: 743–744.

WHEELON, H. 1925 Clinical significance of the congenital absence of the upper lateral incisors. *Endocrinology* **9**: 35–59.

CARNEGIE FOUNDATION'S "BULLETIN NO. 19" ON DENTAL EDUCATION[1]

Is It Possible for a Layman to Offer Opinions "Adequate" for the Improvement of Dental Education?

ALBERT L. MIDGLEY, D.M.D., Sc.D., F.A.C.D.

Providence, R. I.

I have read with surprise, in the January (1928) issue of *Dental Cosmos*, the "review" by Dr. Kells in which he said that "all of the criticisms and suggestions and advice contained in this Bulletin . . . . come from those who have never had anything to do with dentistry or dental education on the inside." I have noted also the editorial endorsement of Dr. Kells' derogatory allusions to "the Carnegie people," "these laymen," and so on. I desire especially to record my *exception to certain aspects and implications of the statement, in that*

[1] The manuscript of this paper was presented, last February, to *Dental Cosmos* for prompt publication in that monthly. The editor rejected it, for two stated reasons; namely: (a) Dr. Gies' comment, then available for the succeeding March issue of *Dental Cosmos* (page 266), was a sufficient reply to Dr. Kells; and (b) it was desirable to restrict the discussion to Dr. Kells (page 53), Dr. Gies, and the editor of *Dental Cosmos* (page 105). I objected to this decision because it made it impossible, in *Dental Cosmos*, for a dentist to speak for dentistry in disagreement especially with the views expressed by the editor of that monthly. Finally the manuscript was sent for publication to Dr. H. W. Gillett, one of the editors of the *Journal of Dental Research*, which fortunately has no commercial, political, or personal axes to grind, and has shown that it "represents an unwavering purpose to keep widely open the channel to freedom of *responsible* and *respectable* expression of truth and opinion, by individuals or organizations, without qualification by or for any views its editors individually may entertain."—[*A. L. M.*]

This paper, received by Dr. H. W. Gillett, was approved by him for publication. The Executive Officer of the Board of Editors, feeling that he should have no voice in a decision on its acceptance, requested that its publication be put to a vote of additional editors. It was then submitted to the Editors of the First District Dental Society of the State of New York and the New York Academy of Dentistry—Drs. John Oppie McCall and Malcolm W. Carr, respectively; also to three who had been members of the group in charge of the *Journal of the Allied Dental Societies*—Drs. William B. Dunning, Arthur H. Merritt, and Bissell B. Palmer, Jr. The paper is published by unanimous approval of these six editorial referees.—[*Ed.*]

editorial (page 105), that "the author of the report is not a dentist or a dental teacher in the sense that he has acquired the knowledge and training furnished by the dental curriculum, yet he essays the rôle of a teacher of dentists insofar as he tells them how and what they should teach. It is a layman's opinion that is offered for consideration by the dental teaching group, and as such is open to the qualification of inadequacy."

This statement, if it were logically sound and professionally becoming, would imply that *no* layman in dentistry, *merely because a layman*, could offer "*adequate*" opinions on the dental curriculum. It would also directly disparage the competency of a layman in dentistry who, since 1909, in a normal evolution of his work as a teacher and investigator in the field of the medico-dental sciences, has shown unusual interest and special activity in dentistry. A summary of Dr. Gies' well-known dental relationships, in addition to those with the Carnegie Foundation in the study of dental education, is pertinent in this relation:

(a) He has conducted and published research under the auspices of city, state, and national dental societies. In recognition of the value of this research he has been elected an honorary member of several dental societies (1909–19).

(b) He coöperated in the establishment of the New York School for Dental Hygienists (now in Columbia University), and was chairman of its executive committee (1916).

(c) He proposed, and was active in, the organization of the Dental School of Columbia University (1916).

(d) He established, and has been editor of, the *Journal of Dental Research*, now in its eighth volume (1919).

(e) He founded the International Association for Dental Research (1920), and, since 1922, has been its Honorary President.[2]

(f) He brought about the union of four national bodies in the American Association of Dental Schools, and was the chairman of its temporary organization (1923).

(g) He received the honor of election to Fellowship in the American College of Dentists (1923).

[2] Elected General Secretary at the Washington meeting in March, 1928.

(h) He also received the award of the medal and scroll of, and honorary membership in, the Rhode Island State Dental Society, in recognition of his eminence in the fields of education, science, and journalism (1927).

(i) He was tendered a testimonial banquet by the New York Academy of Dentistry and associated dental societies, in recognition of his service to dentistry (1927).

At present he is Chairman of the Research Council of the New York Academy of Dentistry, and Chairman of the Dental Advisory Board of the Department of Health of New York City—in each case elected by the votes of dentists. Furthermore, in recognition of his understanding of dentistry and his efforts to advance it, many dentists and a number of dental organizations, coöperating with his former students, have given financial aid in establishing a cumulative research endowment fund in his name at Columbia University, the income from which in its initial year (1927–28) is $1000, and which, during the remainder of his active career, will be directed primarily to the advancement of dentistry.

When, in addition to these well-known facts, one recalls that he received a Ph.D. training at Yale under such distinguished biologists as Verrill and Chittenden; that, among many other professional activities, he has, for nearly thirty-four years, been a teacher of *university* students, undergraduate and graduate, in zoology, physiology, organic chemistry, biological chemistry, and nutrition, at Yale University or Columbia University, especially in schools of medicine, dentistry, pharmacy, and science; and, finally, that since 1909 he has been a member of the Faculty of New York Teachers College, it is clear that the experience thus gained and the dental approval thus accorded demonstrate Dr. Gies' ability to speak for the dentists of the United States and Canada in matters pertaining to the practical growth of dentistry and dental education. His voice cannot be ignored; it is clear, wise, and understanding—and never the voice of a stranger to the councils of dentistry.

But in addition to these facts are some well-known conditions relating directly to the Carnegie Foundation's study of dental education that cannot be disregarded, *as they are in the statement quoted above from the editorial in Dental Cosmos*, without injustice also to the many

dentists who actively coöperated in that work. In the Preface of "Bulletin No. 19," President Pritchett of the Carnegie Foundation makes these statements:

Pages xv–xvi: "The study has been carried out by Dr. Gies with an open mind and with the single desire to be of service to the cause of professional education. It has taken five years to complete the work. This has been due not only to the need to obtain exact facts, but also to the long and patient effort that Dr. Gies has made to understand the situation and to advise with the dental profession. No study of this character has ever been made in which there has been so complete coöperation on the part of the profession itself. The national associations of examiners, of practitioners, and of teachers, the national councils on dental education and the dental schools, both in the United States and in Canada, have all lent themselves to this study in a sincere and patient effort to bring out a helpful and wise conclusion."

Pages xx–xxi: "This study has been conducted under conditions that favored active participation by a large number of representatives of the dental profession, and its promotion has had the aid and encouragement of all of the dental schools and, in general, of those whose interests have been most directly affected. The advice of numerous teachers of the medical sciences and of clinical medicine, and the collaboration of many students of education in its broadest aspects, have been important influences also in the furtherance of the enquiry. The character and extent of the advantages accruing to the study, as a consequence of these exceptional conditions of coöperation and endorsement, have been indicated at the end of the concluding chapter."

Among the acknowledgments to which Dr. Pritchett refers is this allusion on pages 241–2, by Dr. Gies, to the large share and the important influence of dentists in the establishment of the facts that constitute the basis for, and justify, the opinions expressed in the Bulletin:

"Equally gracious in their assistance have been many dental organizations and their officers, in Canada and in the United States, especially the Canadian Association of Dental Faculties, the Dominion Dental Council, the American Academy of Periodontology, the American Dental Association, the American College of Dentists, the National Association of Dental Examiners, the American Institute of

Dental Teachers, the National Association of Dental Faculties, the Dental Faculties Association of American Universities, the American Association of Dental Schools, and the Dental Educational Council of America. Since 1921 it has been the writer's privilege [Gies] to attend the meetings of most of these bodies and there to discuss, formally and informally, many matters of importance in the work. . . . . Outstanding in its influence for the furtherance of the study has been the direct and unstinted coöperation of the Dental Educational Council of America, which actively encouraged united assistance by all in the United States whose interests were most directly affected. The writer [Gies], invited to attend continuously each of the Council's sessions since 1921 and privileged to hear all of the discussions (1922–25), has thus been accorded exceptional opportunity to see clearly many of the special conditions in dental education in America. During the academic year 1921–22, when each of the dental schools in the United States and in Canada was visited at least once, nearly all of the members of the Council, in many special committees of two to four members, accompanying the writer [Gies], gave freely of their time and attention to the observations at each school in both countries, and from their wide experience and detailed knowledge made weighty contributions to an understanding of the situation."

I have observed intimately the care taken to insure accuracy and reliability in the compilation of the data and in the formulation of the conclusions in the Carnegie Foundation's study of dental education, and have also noted the evidences of understanding which, with the welcome help of many well-informed dentists, were voiced in the opinions and deductions of "Bulletin No. 19." Therefore, I protest most earnestly against the superciliousness which would make it appear that dentists are so complacent professionally that they cannot recognize timely and disinterested help from laymen when it is received. To suggest that the officers of the Carnegie Foundation and their assistants, *because* they are laymen in dentistry, cannot offer "adequate" opinions on dental education is reminiscent of the disparagement of Pasteur and other biochemists, physiologists, and physicists, by physicians in their day, because *they* were laymen. The views in the Carnegie Foundation's Bulletin on Dental Education

will be judged by thoughtful, clear-visioned men as were Pasteur's—solely on their merit.

Let us, then, throw into the discard the outworn contention that the knowledge and training furnished by the dental curriculum is necessary before one can offer sound opinions on the improvement of dental education. Is not this idea a vestige of the rejected scheme of isolation in dental education? Have not many of the promoters of medical education lacked the knowledge and training furnished by the medical curriculum? And yet, surely their efforts for the elevation of medicine have been constructive, sympathetic, and welcome to the medical profession and to the public.

1108 Union Trust Building.

ANALYSIS OF STATE DENTAL BOARD EXAMINATIONS IN THE UNITED STATES, WITH COMPARISONS OF FAILURES OF RECENT GRADUATES[1]

F. C. FRIESELL, D.D.S., F.A.C.D.

Dental School, University of Pittsburgh, Pittsburgh, Pa.

Since the research I have to present is universally deemed to be a kind that is as dry as tinder, let us at least start with a smile. You will recall the quotation made by one essayist during the reading of his paper, that "there are three kinds of liars: plain liars, ——liars, and statisticians." Having been thus early introduced and classified, you may realize my embarrassment in appearing before you. However, I wish to offer an addendum to that quotation, to the effect that "figures do not lie, although liars may figure." After seeing the beautiful mathematical demonstration last evening, may I be permitted to borrow one of the equations and substitute for the unknowns the axiom that "things that are equal to the same thing are equal to each other?"

It is proper to explain the origin of this research and to present a brief outline of its scope. About twenty years ago much dissatisfaction existed among the schools because of the blacklisting of some by the National Association of Dental Examiners. Certain of the schools were disqualified because an unusually large proportion of their graduates failed in state board examinations. The schools objected to the embargo, claiming that the records were not in keeping with the facts. A joint meeting of representatives of both associations of examiners and faculties was held for the purpose of arriving at a just and proper understanding of the problem. The result of the conference was a mutual agreement that annually the schools would furnish certified lists of graduates, and each state board would send a report of all the examinations held during the year, to the Chairman

[1] Read at a session of the Sixth Annual Meeting of the International Association for Dental Research, Hotel Mayflower, Washington, D. C., March 25–28, 1928.

TABLE 1

Results of the tabulation of the state board reports for graduates in 1927: all schools

STATE	COLLEGE	TOTAL NUMBER OF GRADUATES	TOTAL NUMBER EXAMINED	EXAMINED: PASSED	EXAMINED: FAILED	PERCENTAGE OF FAILURES	STATES IN WHICH THE EXAMINATIONS WERE HELD
Cal.	Univ. of Cal., Col. of Dent.	88	88	81	7	8.0	1
	Col. of P. and S., School of Dent.	61	59	58	1	1.7	1
	U. of So. Cal., Col. of Dent.	113	112	99	13	11.6	3
Colo.	Univ. of Denver, School of Dent.	28	28	27	1	3.6	6
D. C.	Howard University, Dental School	27	4	3	1	25.0	4
	Georgetown Univ., Dental Dept.	21	20	15	5	25.0	6
Ga.	Atlanta-Southern Dent. College	82	78	78			7
Ill.	Chicago College of Dental Surgery	159	144	143	1	0.7	8
	Northwestern Univ., Dent. School	50	35	35			7
	Univ. of Ill., College of Dent.	22	20	19	1	5.0	1
Ind.	Indiana Univ., School of Dent.	100	90	82	8	8.9	6
Iowa	State Univ. of Iowa, Col. of Dent.	43	40	40			1
Ky.	Univ. of Louisville, School of Dent.	60	58	56	2	3.4	7
La.	Loyola Univ., School of Dent.	26	25	25			5
	Tulane Univ. of La., School of Dent.	22	22	22			3
Md.	Balto. College of D. S., Univ. of Md.	95	84	73	11	13.1	8
Mass.	Tufts College, Dental School	52	49	45	4	8.2	3
	Harvard Univ., Dental School	34	24	23	1	4.2	3
Mich.	Univ. of Mich., Col. of Dent. Surgery	68	68	65	3	4.4	2
Minn.	Univ. of Minn., Col. of Dent.	62	61	59	2	3.3	3
Mo.	Kansas City-Western Dent. Col.	110	76	74	2	2.6	5
	Washington Univ., School of Dent.	16	16	16			2
	St. Louis Univ., School of Dent.	64	64	60	4	6.3	7
Neb.	Univ. of Neb., Col. of Dent.	27	22	17	5	22.7	5
	Creighton Univ., Col. of Dent.	38	37	35	2	5.4	6
N. Y.	New York Univ., Col. of Dent.	124	121	95	26	21.5	2
	Univ. of Buffalo, School of Dent.	44	41	33	8	19.5	1
	Col. Univ., School of Dent. and O. S.	106	103	91	12	11.7	4
Ohio	Western Reserve Univ., School of Dent.	24	24	24			2
	Cinn. College of Dent. Surgery	26	25	20	5	20.0	2
	Ohio State Univ., Col. of Dent.	41	41	40	1	2.4	1
Ore.	No. Pacific Col. of Oregon, Dental School	72	61	41	20	32.8	6
Penna.	Temple Univ., School of Dent.	152	138	124	14	10.1	6
	Univ. of Pgh., School of Dent.	209	208	189	19	9.1	3
	Univ. of Pa., School of Dent.	112	98	86	12	12.2	6
Tenn.	Univ. of Tenn., Col. of Dent.	20	20	19	1	5.0	7
	Meharry Med. Col., Dept. of Dent.	57	31	30	1	3.2	13
Tex.	Baylor Univ., Col. of Dent.	39	38	38			1
	Texas Dental College	22	19	19			1
Va.	Med. Col. of Va., School of Dent.	10	9	9			1
Wisc.	Marquette Univ., Dental School	113	111	102	9	8.1	9
	Total	2,642	2,412	2,210	202	8.4	

Summary:

Number of state board reports received	45
Number of state board reports tabulated	45
Total number of graduates examined and passed	2,210
Total number of graduates examined and failed	202
Percentage of failures	8.4

TABLE 2

Cumulative results of the tabulation of the state board reports for graduates in 1910 to 1927, inclusive: existing schools

STATE	COLLEGE	TOTAL NUMBER OF GRADUATES	TOTAL NUMBER EXAMINED	EXAMINED: PASSED	EXAMINED: FAILED	PERCENTAGE OF FAILURES	STATES IN WHICH THE EXAMINATIONS WERE HELD
Cal.	Univ. of Cal., Col. of Dent.	784	599	562	37	6.2	4
	Col. of P. and S., School of Dent.	755	487	407	80	16.4	4
	Univ. So. Cal., Col. of Dent.	1,162	843	765	78	9.3	10
Col.	Univ. of Denver, School of Dent.	627	590	522	68	11.5	17
D. C.	Howard Univ., Dental School	572	253	176	77	30.4	30
	Georgetown Univ., Dental Dept.	431	335	263	72	21.5	27
Ga.	Atlanta-Southern Dental College	781	769	746	23	3.0	13
Ill.	Chicago College of Dental Surgery	2,259	1,945	1,689	256	13.2	35
	Northwestern Univ., Dental School	2,143	1,764	1,559	205	11.6	40
	Univ. of Ill., College of Dent.	607	541	494	47	8.7	24
Ind.	Indiana Univ., School of Dent.	1,124	1,082	993	89	8.2	22
Iowa	State Univ. of Iowa, Col. of Dent.	995	951	907	44	4.6	16
Ky.	Univ. of Louisville, School of Dent.	730	664	596	68	10.2	31
La.	Loyola Univ., School of Dent.	137	119	118	1	0.8	10
	Tulane Univ. of La., School of Dent.	387	316	297	19	6.0	14
Md.	Balto. Col. of D. S., Univ. of Md.	1,138	971	746	225	23.2	27
Mass.	Tufts College, Dental School	1,499	1,321	1,183	138	10.4	11
	Harvard Univ., Dental School	808	628	552	76	12.1	18
Mich.	Univ. of Mich., Col. of Dent. Surg.	1,379	1,273	1,238	35	2.7	20
Minn.	Univ. of Minn., Col. of Dent.	1,348	1,237	1,158	79	6.4	14
Mo.	Kansas City-Western Dental Col.	603	519	503	16	3.1	17
	Washington Univ., School of Dent.	474	449	433	16	3.6	11
	St. Louis Univ., School of Dent.	1,014	941	886	55	5.8	24
Neb.	Univ. of Neb., College of Dent.	352	323	306	17	5.3	9
	Creighton Univ., College of Dent.	489	472	445	27	5.7	14
N. Y.	New York Univ., College of Dent.	2,625	2,395	1,735	660	27.6	6
	Univ. of Buffalo, School of Dent.	853	807	635	172	21.3	8
	Columbia Univ., School of D. and O. Surg.	510	492	378	114	23.2	4
Ohio	Western Reserve U., School of Dent.	649	614	536	78	12.7	5
	Cinn. College of Dental Surgery	207	178	133	45	25.3	11
	Ohio State Univ., Col. of Dent.	640	614	571	43	7.0	11
Ore.	No. Pacific Col. of Oregon, Dental School	1,423	1,179	915	264	22.4	16
Penna.	Temple Univ., School of Dent.	1,065	894	755	139	15.5	21
	Univ. of Pgh., School of Dent.	1,679	1,627	1,572	55	3.4	15
	Univ. of Pa., School of Dent.	2,816	2,069	1,682	387	18.7	28
Tenn.	Univ. of Tenn., Col. of Dent.	278	261	245	16	6.1	15
	Meharry Med. Col., Dept. of Dent.	759	613	460	153	25.0	31
Tex.	Baylor Univ., Col. of Dent.	434	351	317	34	9.7	5
	Texas Dental College	264	211	182	29	13.7	4
Va.	Med. College of Va., School of D.	287	272	254	18	6.6	6
Wisc.	Marquette Univ., Dental School	1,366	1,243	1,148	95	7.6	23
	Total	38,453	33,212	29,062	4,150	12.5	
	Totals for schools that have been discontinued (see Table 3)	6,247	5,470	4,343	1,127	20.6	

Summary: Total number of graduates examined and passed..... 29,062
Total number of graduates examined and failed..... 4,150
Percentage of failures..... 12.5

of the Tabulation Committee of the National Association of Dental Examiners. After the Tabulation Committee completed the tabulation, all of the state board reports were to be sent to the Tabulation

TABLE 3

Cumulative results of the tabulation of the state board reports for graduates in 1910 to 1926, inclusive: schools discontinued since 1910

STATE	COLLEGE	TOTAL NUMBER OF GRADUATES	TOTAL NUMBER EXAMINED	EXAMINED: PASSED	EXAMINED: FAILED	PERCENTAGE OF FAILURES	STATES IN WHICH THE EXAMINATIONS WERE HELD
Ala.	Birmingham Dental College	54	50	38	12	24.0	1
D. C.	Geo. Washington Univ., Dept. of Dent.	185	137	108	29	21.2	13
Ga.	Southern Dental College	362	337	303	34	10.0	10
	Atlanta Dental College	472	441	367	74	16.8	15
	So. Eastern Dental Univ.	2	2		2	100.0	2
Iowa	Drake University, Col. of Dent.	32	29	29			1
La.	Louisiana State Col. of Dent. Surg.	6					
Md.	Balto. College of Dental Surgery[1]	775	564	392	172	30.5	23
	Balto. Medical Col., Dental Dept.	83	64	43	21	32.8	12
Mo.	Kansas City Dental College	514	470	434	36	7.7	14
	Western Dental College	456	413	366	47	11.4	18
	Barnes School of Dentistry	82	70	55	15	21.4	5
N. J.	College of Jersey City, Dental Dept.	57	53	7	46	86.8	1
N. Y.	College of D. and O. Surg. of N. Y.[2]	1,457	1,367	976	391	28.6	6
Ohio	Ohio College of Dental Surgery	655	572	445	127	22.2	23
Penna.	Med. Chi. College Dental Dept.	348	248	176	72	29.0	9
Tenn.	Vanderbilt Univ., School of Dent.	613	574	544	30	5.2	22
	Univ. of Memphis, Dental Dept.	5	4	4			3
	Univ. of W. Tenn., Col. of Dent. Surg.	40	28	18	10	35.7	5
Va.	Univ. Col. Medicine, Dental Dept.	32	30	23	7	23.3	2
Wisc.	Wisc. Col. P. and S. Dental Dept.	17	17	15	2	11.8	1
	Total	6,247	5,470	4,343	1,127	20.6	

[1] Before union with the Dental School of the University of Maryland.
[2] Before union with the Dental School of Columbia University.

Committee of the Faculties Association to be audited. When this audit was completed, the two chairmen would meet, compare figures, and make such corrections as were shown by the records to be neces-

TABLE 4

Results of the tabulation of the state board reports for graduates in 1923 to 1927, inclusive: all schools

STATE	COLLEGE	NUMBER EXAMINED IN OWN STATE	PERCENTAGE OF FAILURES IN OWN STATE	PERCENTAGE OF FAILURES IN OTHER STATES	NUMBER EXAMINED IN OTHER STATES	TOTAL NUMBER EXAMINED: FIRST EXAMINATION	PERCENTAGE OF FAILURES: FIRST EXAMINATION	PERCENTAGE OF FAILURES: INCLUDING MULTIPLE EXAMINATIONS	TOTAL NUMBER EXAMINED: INCLUDING MULTIPLE EXAMINATIONS	STATES IN WHICH THE EXAMINATIONS WERE HELD
Cal.	Univ. of Cal., Col. of Dent.	399	7.0		2	401	7.2	7.6	406	3
	Col. of P. and S., School of Dent.	285	14.4	50.0	2	287	14.6	14.3	294	2
	U. of So. Cal., Col. of Dent.	567	9.9	25.0	8	575	10.1	10.2	627	5
Colo.	Univ. of Denver, School of Dent.	171	14.6	41.2	17	188	17.0	17.5	262	10
D. C.	Howard University, Dental School	9		34.3	102	111	31.5	33.6	116	21
	Georgetown Univ., Dental Dept.	57	10.5	27.9	43	100	18.0	18.6	102	12
Ga.	Atlanta-Southern Dent. College	328	0.3	4.3	115	443	1.4	4.1	728	12
Ill.	Chicago College of Dental Surgery	494	0.4	9.6	73	567	1.6	3.2	624	20
	Northwestern Univ., Dent. School	352	1.4	20.3	128	480	6.5	6.7	555	28
	Univ. of Ill., College of Dent.	156	2.6	6.2	16	172	2.9	3.7	187	8
Ind.	Indiana Univ., School of Dent.	374	6.4	12.0	58	432	7.2	8.2	464	16
Iowa	State Univ. of Iowa, Col. of Dent.	292	2.7	66.7	3	295	3.4	5.0	358	4
Ky.	Univ. of Louisville, School of Dent.	136	1.5	18.4	49	185	6.0	9.0	244	15
La.	Loyola Univ., School of Dent.	56		5.3	18	74	1.3	5.9	84	8
	Tulane Univ. of La., School of Dent.	107		11.1	18	125	1.6	6.3	158	9
Md.	Balto. College of Dent. Surg.	21	38.1	45.1	31	52	42.3	42.3	52	11
	Balto. College of D. S. Univ. of Md.	245	7.7	37.3	193	438	20.8	26.0	592	20
Mass.	Tufts College, Dental School	330	8.2	44.4	54	384	13.3	14.6	480	11
	Harvard Univ., Dental School	143	7.7	27.6	47	190	12.6	15.1	225	12
Mich.	Univ. of Mich., Col. of Dent. Surgery	414	1.4		6	420	1.4	5.1	490	5
Minn.	Univ. of Minn., Col. of Dent.	369	5.9	19.2	26	395	6.8	9.3	452	11
Mo.	Kansas City-Western Dent. Col.	257	1.2	7.0	141	398	3.3	5.0	496	17
	Washington Univ., School of Dent.	84	3.6	8.3	12	96	4.2	5.6	143	3
	St. Louis Univ., School of Dent.	249	0.8	20.9	86	335	6.0	6.5	448	16
Neb.	Univ. of Neb., Col. of Dent.	93	11.8	6.7	15	108	15.0	13.9	129	8
	Creighton Univ., Col. of Dent.	120	2.5	15.6	64	184	7.1	8.6	278	12
N. Y.	Col. of Dental and Oral Surgery of N. Y.	154	37.6	46.7	15	169	38.5	39.3	173	4
	New York Univ., Col. of Dent.	715	23.1	50.0	70	785	25.5	25.5	842	4
	Univ. of Buffalo, School of Dent.	232	18.9	100.0	1	233	19.3	19.7	243	2
	Columbia Univ., School of Dent. and O. S.	466	21.0	61.5	26	492	23.2	23.1	558	4
Ohio	Ohio Col. Dental Surgery	118	18.6	47.4	57	175	16.6	16.7	198	9
	Western Reserve Univ., School of Dent.	205			2	207			210	2
	Cinn. Col. of Dent. Surgery	56	8.9	12.5	8	64	9.4	9.0	66	4
	Ohio State Univ., Col. of Dent.	195	1.5		2	197	1.5	1.5	197	3
Ore.	No. Pacific College of Oregon, Dental School	300	29.7	23.4	256	556	26.6	26.1	854	12
Penna.	Temple Univ., School of Dent.	434	6.4	45.7	35	469	9.4	17.6	562	11
	Univ. of Pittsburgh, School of Dent.	865	3.0	26.3	19	884	3.5	4.8	957	9
	Univ. of Penna., School of Dent.	380	3.4	35.3	232	612	15.5	20.1	807	14
Tenn.	Univ. of Tenn., Col. of Dent.	73		6.4	31	104	1.9	2.7	110	10
	Meharry Med. Col., Dept. of Dent.	26	11.5	22.0	245	271	24.7	28.2	297	28
	Vanderbilt Univ., Col. of Dent.	81		6.9	116	197	4.1	12.3	259	20
	Univ. of W. Tenn., Col. of Dent.	2	100.0	50.0	4	6	66.7	50.0	8	4
Tex.	Baylor Univ., Col. of Dent.	141	4.2		3	144	4.2	5.6	161	4
	Texas Dental College	96	7.3	14.3	7	103	7.8	8.4	107	4
Va.	Med. Col. of Va., School of Dent.	97			7	104		2.5	121	2
Wisc.	Marquette Univ., Dental School	540	2.8	24.0	108	648	6.3	8.0	735	18
	Total[1]	11,284	8.0	24.2	2,601	13,885	11.0	12.8	16,443	

[1] Total number of graduates: all schools (five years), 15,925.

TABLE 5

Cumulative record of the examinations in the individual states, in 1910 to 1927, inclusive: all schools

STATE	TOTAL NUMBER EXAMINED	TOTAL NUMBER OF FAILURES	PERCENTAGE OF FAILURES
Alabama	224	32	14.3
Arizona	11	2	18.2
Arkansas	140	9	6.4
California	1,926	207	10.7
Colorado	563	59	10.5
Connecticut	302	144	47.7
Delaware	35	7	20 0
Dist. of Columbia	301	43	14.3
Florida	116	9	7.7
Georgia	1,235	104	8.4
Idaho	55	13	23.6
Illinois	3,526	311	8.8
Indiana	1,210	113	9.3
Iowa	1,149	143	12.4
Kansas	571	8	1.4
Kentucky	578	45	7.8
Louisiana	446	10	2.2
Maine	138	5	3.8
Maryland	919	137	14.9
Massachusetts	1,950	259	13.3
Michigan	1,327	56	4.2
Minnesota	1,429	173	12.1
Mississippi	105	15	14.3
Missouri	1,886	79	4.2
Montana	90	15	16.7
Nebraska	720	41	5.7
Nevada	2		
New Hampshire	80	18	22.5
New Jersey	659	450	68.3
New Mexico	14	1	7.1
New York	5,436	1,429	26.3
North Carolina	282	62	22.0
North Dakota	81	16	19.7
Ohio	1,877	286	15.2
Oklahoma	158	14	8.9
Oregon	774	169	21.8
Pennsylvania	3,908	273	7.0
Rhode Island	125	25	20.0
South Carolina	162	26	16.0
South Dakota	95	31	32.6
Tennessee	652	21	3.2
Texas	819	103	12.6
Utah	178	31	17.4
Vermont	38	8	21.0
Virginia	372	58	15.6
Washington	429	105	24.5
West Virginia	281	43	15.3
Wisconsin	1,259	63	5.0
Wyoming	30	2	6.7
Porto Rico	19	4	21.0
Total	38,682	5,277	13.6

sary and affix their signatures to the audit, officially acknowledging thereby the correctness of the results, which were to be published in the proceedings of each organization (National Association of Dental Examiners and National Association of Dental Faculties).

After two years' experience in tabulating, the use of printed forms and a permanent book-form made it possible to compile the yearly records uniformly for an indefinite number of years.

It was mutually agreed that the record should include only the results of the first examination taken by graduates during the calendar year in which they graduated, since the greater number of graduates would thus be included and the arrangement would be equally fair to all schools.

Annually, at the completion of the tabulation, a notice is sent to the dean of each school, giving the names of failures for his school and the state in which the examinations were taken. A request is also made that this list, if correct, be returned to the Tabulation Committee certified with the signature of the dean or proper official; but if not admitted to be correct, with a statement indicating the errors.

All cases of disputed rating are taken up with the state board secretaries concerned and necessary adjustments are made in the cumulative records of the schools. With forty-one schools and forty-nine state board secretaries, as at present, occasional errors are unavoidable. In the early years of this work a number of the school officials displayed a lukewarm interest regarding failures, but it is a pleasure to note that an active interest in the state board records of the schools is now being manifested.

The accompanying tables present the following data:

Table 1: Total number of graduates; number examined; number passed; number failed; percentage of failures; number of states in which the examinations were held; period—*calendar year 1927*

Table 2: Total number of graduates; number examined; number passed; number failed; percentage of failures; number of states in which the examinations were held; period—eighteen years, *1910–1927*, inclusive (*existing schools*)

Table 3: Total number of graduates; number examined; number passed; number failed; percentage of failures; number of states in which the exam-

inations were held; period—17 years, *1910–1926*, inclusive (*schools discontinued since 1910*)

Table 4: Number of graduates examined in *home states* and percentage of failures; number examined in *other than home states* and percentage of failures; total number examined: *first* examinations, and percentage of failures; *multiple* examinations, and percentage of failures; number of states in which the examinations were held; period—5 years, *1923–1927*, inclusive

Table 5: Cumulative record of the examinations in the *individual states;* total number examined; number failed; percentage of failures; period—18 years, *1910–1927*, inclusive

Some interesting facts are indicated by these tables. The total number of graduates of 62 schools was 44,700, of which only 38,682 took license examinations, and 5,277 failed to pass at the first trial.[2] During this period 21 schools were discontinued.

Of the 33,212 graduates of the 41 surviving schools who were examned, 4,150 failed—12.5 percent of failures. Of the 5,470 graduates of the 21 defunct schools who were examined, 1,127 failed—20.6 percent of failures. The percentages of failures for individual schools varied from 0.8 percent to 30.4 percent. Percentages of failures, as they occurred in the examinations in the individual states, ranged from 1.4 percent to 68.3 percent.

The average percentage of failures of a school's graduates in the home state was 8 percent; the average in states other than the home state was 24.2 percent. In 1927, of the 2642 graduates in dentistry in the United States, only 2412 were examined by state boards, 2210 having passed, 202 having failed—a percentage of failures of 8.4 percent as against the cumulative average of 12.5 percent for the same schools for the eighteen-year period.

[2]All of the data in the succeeding two paragraphs refer to the results of initial attempts to pass license examinations in the calendar year of graduation.

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Scientific Proceedings of the Sixth Annual Meeting: March 25–28, 1928[1]

Compiled by WILLIAM J. GIES, F.A.C.D.[2]

Secretary of the Committee on Organization, New York City

CONTENTS

I. President's Address..... 395
II. First session: Afternoon, March 25; Abstracts nos. 1–9..... 400
III. Second session: Evening, March 25; Abstracts nos. 10–15..... 413
IV. Third session: Evening, March 26; Abstracts nos. 16–24..... 417
V. Fourth session: Evening, March 27; Abstracts nos. 25–32..... 428
VI. Fifth session: Afternoon, March 28; Abstracts nos. 33–47..... 439
VII. List of the officers, and new members, elected March 26–28..... 460

I. President's Address[3]

Leroy M. S. Miner, D.M.D., M.D., Dental School, Harvard University, Boston, Mass.

A. Introduction

The late President Charles W. Eliot is credited with the observation that the progress made by any profession is dependent largely upon

[1] Each session of the meeting (except one as noted), and the informal dinners on the evenings of March 25, 26, and 27, were held in the North Room of the Mayflower Hotel, Washington, D. C. The chairman at the sessions was Leroy M. S. Miner, Harvard University, President, or R. W. Bunting, University of Michigan, Vice-President, of the Association. To prevent confliction with the program of the coincident Fifth Annual Meeting of the American Association of Dental Schools, at the same hotel, no sessions were convened during the mornings or afternoons of March 26 and 27, and none on the morning of March 28. An account of the executive proceedings will be published in the supplement of this volume, in the number for December, 1928. Abstracts of the papers presented at the first five annual meetings of the Association were published in the last preceding issue of the *Journal of Dental Research:* 1928, viii, pp. 209–229.

[2] Most of the abstracts have been prepared by those who presented the corresponding papers. All have been verified by the authors.

[3] Delivered at the opening of the second session, after the Association's informal dinner on March 25. See page 413.

the quality of its research. The indifference of both the dentist and the physician to original investigation of the biological problems related to the broad field of stomatology has retarded progress in a fundamental appreciation of the importance of these relationships.

Intensive study of the mechanical problems of dentistry, and the resulting remarkable development in this field of dental service for a long period, almost entirely diverted attention from cell and tissue reactions in the mouth and in the organism as a whole. Mechanics overlooked and often even initiated pathology, partly due to the fact that commonly no local primary symptoms developed following mechanical treatment. When it became apparent, however, that these seemingly innocent deviations from normal in the mouth could be the source of serious secondary symptoms in various parts of the body, then, and not until then, did we begin to appreciate the biological importance of teeth in both health and disease. It became increasingly clear to all those who gave this matter any thought that a complete change in the philosophy of dentistry and dental service must be made; that a new attitude must be developed, not only by dentistry but by medicine as well, toward fundamental dental problems; and that the need for substantial scientific research in biological relationship was paramount.

Many in both professions discussed this subject from various viewpoints. There was rather general agreement that a serious defect in caring for the health of the nation existed. To Professor Gies belongs the credit for seeing not only the real root of the trouble, but also for developing a constructive program for eliminating it. This program contained three important parts: First, the establishment of the *Journal of Dental Research;* second, the formation of the International Association for Dental Research; third, an effort to develop an interest in the support of dental research in dental and medical schools.

The *Journal of Dental Research,* established in 1919, now speaks for itself. It is an achievement in dental journalism of which dentistry should feel proud. That it is conducted with as high scientific, literary, and ethical standards as any of the journals in medicine or biology is a generally accepted fact.

The second item on Professor Gies' program, the International Association for Dental Research, was founded in December, 1920,

"in order to promote broadly the advancement of active research in all branches of dentistry and in related phases of the arts and sciences that contribute directly to the development of dentistry. And further to encourage and facilitate coöperative effort and achievement by, and mutual helpfulness among, investigators in all nations in every division of stomatology to the end that dentistry may render cumulatively more perfect service to humanity."

These are worthy aspirations, and should inspire every one who has the interests of dentistry at heart to make them realities. The charter members of this Association were primarily interested in research and in the development of research, not in organization machinery. Hence, the regulations for conducting its affairs were made as simple as possible. As a result it is happily free from professional politics.

Slow, quiet, but substantial growth, has marked the years of its existence. The various sections have developed their local interests as they desired, but the interests of the whole have been developed at the annual meetings. Usually these have been coincident with the meetings of the Association of American Dental Schools. One year our Association furnished the program for one of the sessions of that organization, but announcement of this fact was omitted from the program of the American Association of Dental Schools.[3a]

At the annual meeting held in New York last April, an Organization Committee was appointed to coördinate the activities of the Association, that its work might be made increasingly effective. Dr. Gies, as Secretary of this committee, has been untiringly active, and I feel sure that this meeting marks the development of a virility which should make this Association a very effective instrument for the service of mankind.

B. Membership

There are many phases of the work of this Association which might be discussed in a president's address. I prefer, however, to concentrate my efforts and discuss only the matter of membership, leaving plenty of ammunition for future presidents to consider.

[3a] See the Proceedings of the Third Annual Meeting of the International Association for Dental Research: *Journal of Dental Research*, 1928, viii, p. 215.

There are, it seems to me, at least three groups of men and women who might be interested in dental research: First, the investigators; second, the administrators; and third, the donators.

Article IV, Section 1, of the constitution defines eligibility for membership as follows:

"Any person who has conducted and published an account of a meritorious original investigation in dental science or in any of the sciences contributory to stomatology, shall be eligible to membership in this association, providing such person conforms to the recognized standards of professional ethics."

Clearly, the purpose of this organization was to afford a means by which those pursuing investigations in dental science could convene at stated intervals and obtain the benefits which naturally come from collaboration and association. Hence the eligibility provisions in Section 1.

The *second group*, the administrators, need, however, stimulation, education, and encouragement in matters of research far more than do the investigators. The investigators are already interested, and are only anxious for greater opportunities to pursue quest of the unknown. Deans of dental schools and of medical schools, superintendents of hospitals, and directors of dental infirmaries, on the other hand, are frequently indifferent, and yet by their influence research matters could be made to flourish. While these men may not be able actually to undertake serious research themselves, are they not in position to promote broadly and effectively the advancement of active research in all branches of dentistry? Activity in research in all these institutions is far below what it should be, and in many instances none whatever is being done. No doubt there are numerous causes for this, but an indifferent attitude is one of them. The Organization Committee tried very hard to show the officers of the American Association of Dental Schools good reasons for holding a joint session of the School and Research Associations, so that this phase of dental school activity might have special recognition. But these efforts were unsuccessful, which seems most unfortunate.

Is it not a proper function of this Association to help correct these deficiencies, which are retarding the progress of dentistry? And may

not this be done in part by making it possible for these administrators to become members of this Association?

The success of the two-three-graduate plan of dental education proposed by Dr. Gies in Bulletin Nineteen of the Carnegie Foundation for the Advancement of Teaching, must depend, in my opinion, for its success, in considerable part upon the effectiveness of the graduate program. The graduate program, to be effective must be, in quality of instruction and character of work done, of real post-graduate grade equal to, and comparable with, graduate instruction and work in any of the professional or graduate schools in the University. This quality of instruction in turn must depend on the development of an adequate research program. Therefore, the two-three-graduate plan is dependent on the development of an adequate research program; and what is true of the two-three-graduate plan is equally true in the last analysis of any forward looking plan of dental education. If this reasoning be sound, is it not most important for administrators of both dental and medical schools, and directors of their clinical adjuncts, the hospital and dental infirmary, to be thrown as much as possible into a research atmosphere, and be imbued with its importance. Surely the answer to this is in the affirmative. We have, then, good reason for adding a clause to Section 1 of Article IV, making deans of dental and medical schools and hospital superintendents eligible for membership. If a distinction in the type is desirable, that can be provided for.

The *third group*, the donators, are a necessary part of this research ensemble. No one has yet been able to demonstrate satisfactorily which one of the legs is the most necessary in a three-legged stool. No matter how enthusiastic an investigator may be and how sympathetic an administrator may be, research matters may be flat until the donator comes along and supplies the necessary funds. This organization at the present time is entirely free from all commercial entanglements, and to do its most effective work, must remain forever so. But this organization may be of great help in advancing the third part of Dr. Gies' program, namely, the development of support of dental research in dental and medical schools, and thereby promoting the whole cause of dentistry, through its influence in demonstrating to men philanthropically inclined the opportunity for real service to

humanity by providing funds for research. Members of this donator group, moreover, without medical or dental training, frequently may give valuable advice in matters of fundamental importance.

In serving on a Board of Trustees of a dental infirmary, made up of not only dental and medical men, but men trained in law and in business, it has been my experience that frequently the lay group offered most stimulating suggestions. Might not this experience be duplicated on occasion, if donators to dental research could be encouraged to attend these meetings? And would it add any complication to our machinery to provide an honorary membership for large donators of funds to dental research? Such a course might prove mutually helpful.

As I stated at the beginning, the machinery of this organization was made as simple as possible. Research is a matter that cannot be politicized, standardized, or organized to any advantage. Each problem is an adventure into the frontiers of knowledge, and the method of attack depends not a little upon the character of that frontier. Vision, imagination, courage, patience, and persistence, are as important and necessary as acquaintance with the fields of knowledge already conquered, and with the fundamental principles involved in acquiring that mastery. But research may be nurtured, developed, stimulated, and encouraged, so that a spark may set ablaze the spirit of inquiry in places where no life has been. In other places, two pieces of research may spring up where only one was before. To nurture, to develop, to stimulate, to encourage, as well as to do, research, must forever continue to be important functions of this Association.

II. First Session: Afternoon, March 25

1. The relation of diet to the skeletal development of swine, including the development of teeth

H. E. Kelsey, D.D.S., F.A.C.D., Baltimore, Maryland, and E. V. McCollum, Ph.D., Johns Hopkins University, Baltimore, Maryland, coöperating with S. S. Buckley, D.V.M., and Paul E. Howe, Ph.D., United States Department of Agriculture, Washington, D. C.

I. Paul E. Howe

The American Dental Association, through Dr. McCollum of Johns Hopkins University, approached Dr. Mohler of the Bureau of Animal Industry with regard to the study of the influence of faulty nutrition on the development of the teeth of swine. The problems presented are closely related to those of skeletal development during pregnancy, lactation, and growth and general development of animals, in which the Animal Husbandry Division is concerned. A cooperative agreement was entered into, between the American Dental Association through the Johns Hopkins University and the Animal Husbandry Division of the U. S. Department of Agriculture, to study "the relation of diet to the skeletal development of swine, including the development of teeth in pigs." It is assumed that this study will continue a number of years; in fact definite results cannot be expected in a short time. The first series of experiments relates to the influence of high calcium and high phosphorus rations, used for rats, upon the development of a slower growing animal, the pig. The work has only been begun. Fourteen sows and their litters have been set aside for this work, and specially constructed houses and yards have been produced.

II. H. E. Kelsey

The objective of the work, some of which will be done at the School of Hygiene, is similar to that of the experiments which for years Dr. McCollum has carried on with smaller animals; namely, to discover the effects of defective diet on the animal as a whole, the interest of the Research Commission of the American Dental Association being of course more particularly centered upon the results in the skeleton and particularly the head, jaws, and teeth of the specimens, thus obtained.

Some years ago Dr. McCollum conducting experiments upon larger animals, chiefly cattle, drew some valuable conclusions, but with this exception little or nothing has been tried with animals having a period of gestation and lactation approximating those of man. If such experiments were carried out with the utmost fidelity and accuracy to the smallest detail, the result should simulate more nearly those which would be produced in similar experiments in man, the conditions

of which no doubt are being repeatedly produced by accident, for man's diet tends constantly to be deficient through ignorance or otherwise in the selection of food. During the long period in which swine will be subjected to dietary deficiency, effects should be registered upon the skeletal development, and we hope upon the teeth, that might not occur in shorter experiment on small animals.

In talking with Dr. McCollum, these features impressed me strongly. The Research Commission of the American Dental Association made available $1800 for the first year (renewed for the second) toward the expenses of conducting this experiment, this being all, in view of other grants, the Commission could devote to it. Dr. McCollum did not believe that this would be sufficient, but we thought that additional funds might be raised to carry on the experiment. Dr. McCollum aroused the interest of Dr. Paul E. Howe and others of the Bureau of Animal Industry, and their proffered cooperation was gladly accepted. Dr. John R. Mohler, the head of the Bureau, Mr. E. W. Sheets, Mr. Ben F. Brandon, and Dr. S. S. Buckley, have given much time and painstaking care to such phases of the experiment as have already been inaugurated, and it is only fair to say that the Department through the Bureau has been contributing much more heavily to the expenses than we were able to do; and both we and they hope and believe that the results will be of great value to the Bureau as well as to dental and medical science. To have a biochemist such as Dr. Paul E. Howe; a veterinarian of long experience with accurate knowledge of the requirements of this work, such as Dr. S. S. Buckley; and someone to look after many of the physical details of the experiment, such as Mr. Ben F. Brandon, the manager of the Experimental Farm, is good fortune that at the outset we did not anticipate.

The Bureau has provided adequate facilities for the experiment, having built concrete enclosures, with suitable houses, proper water supply, facilities for weighing, mixing, and caring for special feeds, and many other important details, besides purchasing thirteen sows, suitable for the experiment and their breeding, which result in securing altogether eighty or ninety animals. The diet, which Dr. McCollum has formulated, has been rigidly adhered to in their feeding, and the animals that have died have been preserved. Twelve to twenty specimens are now available for study, and more are being added to

them, as animals die or are killed at suitable periods. It is also planned to secure a large number of normal skeletons of all ages, for comparison, which can easily be accomplished at a place where annually about 2000 swine are killed, in experiments to determine the cause of various characteristics of commercial pork, etc.

Both the American Dental Association and the Department of Agriculture appreciate that they are given the benefit of the experience and knowledge of one of the leading authorities in the world on diet and its relation to growth and development, and it is our hope that Dr. McCollum will be supported in this experiment for at least five or six years. It should be carried on indefinitely.

2. ROOT DEVELOPMENT, AND THE LIGHT IT THROWS ON CERTAIN PECULIARITIES OF THE ROOTS AND ROOT-CANALS

W. H. F. Addison, A.B., M.B., and J. L. T. Appleton, Jr., B.S., D.D.S., University of Pennsylvania, Philadelphia, Pa.

Lateral extensions from the pulp canal to the alveolo-dental periosteum, lying distinctly coronad to the region of the foraminal delta, are well known. In a study of the development of the roots of the molars of the white rat, such lateral canals were frequently found. In all cases they were directed toward the axis of the tooth. An examination of all the plates in Hess and Zuercher's Anatomy of the root-canals, etc. (London, 1925) showed that also in human teeth these lateral canals ("Markkanaele") run without exception axially. The lines along which these canals occur represent the lines of fusion of the several "tongues" of Hertwig's epithelial sheath, which determine the floor of the pulp chamber and the site, number, and cross-sectional outline of the roots. Such lines of fusion may be lines of weakness or lines of imperfect development; e.g., the raphe of the scrotum, and the maxillo-premaxillary suture. Examination of the developing roots of the white rat showed occasional interruptions in the continuity of the epithelial sheath, of the odontoblasts, and of the deposition of dentin. These defects invariably were localized to the axial aspect of the root. The inference was drawn that the lateral canals in the mature tooth represent developmental defects incident to the behavior of the epithelial sheath in the formation of the roots.

The occurrence of such lateral canals in teeth with a single root offers a difficulty in generalizing the above interpretation. Previously[4] defects in the floor of the pulp chamber have been ascribed to essentially the same process; viz., lines of fusion present loci along which development may be imperfect or interrupted.

The authors expect to make an extensive report on root development before the end of the year.

3. CHANGES IN THE ELECTRICAL RESISTANCE OF THE ENAMEL AS A MEASURE OF PERMEABILITY TO SALTS

Henry Klein,[4a] and William R. Amberson, Ph.D., Department of Physiology, Medical School, and Thomas W. Evans Museum and Dental Institute, Dental School, University of Pennsylvania, Philadelphia, Pa.

Changes in the electrical resistance of the enamel, when exposed to salts, indicate a salt penetration into the structure. Enamel cups can be prepared from canine teeth, carefully extracted from dogs, by using a dental drill to remove as much of the dentine as possible without fracturing the enamel. The cups so prepared are then immersed in distilled water for from one to two months to remove salts and other contained or adherent soluble substances. After this treatment, the cups are arranged in a vacuum-tube resistance recorder, which measures the resistance of the cup to a thousand cycle alternating current. The tip of the cup is immersed in a dilute salt solution. The resistance is read immediately after the tip is placed in the salt solution, and readings are taken at frequent intervals over a period of 24–48 hours. The initial resistance is approximately 900,000 ohms, but gradually falls during 48 hours to about 5000 ohms. The final resistance of the cup at equilibrium varies, owing to inequalities in size, number of pores, and thickness of the different cups.

The rate of fall in the resistance of any cup, a function of the concentration of the salt outside the tip, is more rapid with molecular potassium chloride against the tip than with tenth molecular potassium chloride. Decreased resistance indicates penetration by the salt into the enamel in response to the existing diffusion gradient.

[4] Weski und Contreras: Befunde und Vorgaenge im interradikulaerraume mehrwurzeligen Zaehne. *Vrtljhrschrft. f. Zhnhlk.*, 1924, xl, p. 229.

[4a] Senior student of dentistry: Dental School, University of Pennsylvania.

4. VARIATIONS IN THE PERIODONTAL STRUCTURES OF ERUPTING AND RECENTLY ERUPTED TEETH, AS DISCLOSED BY THE ROENTGENOGRAM

John Oppie McCall, A.B., D.D.S., F.A.A.P., F.A.C.D., College of Dentistry, New York University, New York City

Study of intraoral radiograms, selected from a representative orthodontic file (Dr. F. L. Stanton), has disclosed marked variations in the periodontal structures of erupting and recently erupted teeth. These variations seem not to be directly related to the age of the individual or to the rate of eruption in terms of the age. They have a possible significance in connection with susceptibility or immunity to periodontal disease.

In what seems to be a normal case, the erupting tooth exhibits (in the radiographic negative) a dark zone around its crown, and has roughly the same shape as the crown. When the root begins to form, this dark zone follows its outline and becomes constricted at the neck of the tooth to a thin black line, representing the pericementum. At the apical end of the developing root, this dark line expands and blends into a dark zone, somewhat circular in shape, which encircles the end of the root. This zone, is not as dark, i.e., not as radiolucent, as the pericoronal zone. The density of this region becomes progressively greater as the root develops. Prior to eruption the so-called lamina dura is inconspicuous; or, in other words, the bone forming the alveolar wall is not as dense at this time as it is after the eruption of the tooth brings to it the stimulus of function.

After eruption the lamina dura develops a density that has caused it to be given this name. It is represented, in what seem to be normal cases, by a narrow white line, and the pericementum is represented by a black line, which is so narrow as to be almost imperceptible at certain angles. The dark zone at the root-end is now of nearly the same density as the surrounding bone, the immature root being denoted as such chiefly by its funnel shaped orifice.

Variations from what seem to be normal are indicated by increased width of the pericemental line, increased width and density of the so-called lamina dura, and increased radiolucence of the circular zone over the root end. In some instances it may be determined by clinical

examination that these variations have been brought about by traumatic occlusion, this opinion being confirmed by the fact that they are not uniformly distributed in the mouth. In many cases this factor is lacking, and the variation must seemingly be attributed to nutritional disturbances. It is a striking phenomenon that such variations are not always accompanied by variations in the mouth tissues discernible by local examination.

The conclusion may be drawn that such variations in the periodontal structures are possible indications of a nutritional short-coming, and also that they may point to a predisposition to periodontal disease, which might not otherwise manifest itself for many years. The intraoral radiogram properly interpreted may thus be useful as a guide to the nutritional state of the individual, and may point the way to dietary or therapeutic measures needed for the general welfare. It may also, through these measures, enable the individual to build up an adequate resistance against periodontal disease. It thus plays an important part in the preventive dental program. Further research is much needed.

5. BONE CHANGES AND THEIR SIGNIFICANCE

Egon Neustadt, M.U.D. (Vienna), College of Dentistry, New York University, New York City

Changes that occur in the bone are the result of the reaction of cells. The cells in question are the bone cells proper, the osteoblasts, osteoclasts, and the embryonic connective-tissue cells in periosteum, periodontium, and endosteum. These cells react to certain stimuli; if the stimuli change, the structure of the bone changes. The stimuli act either in the direction of higher or diminished vitality, and they produce bone condensation or rarefaction respectively. Either of these changes may be produced by physiologic or by pathologic stimuli, and we may, therefore, speak of physiologic condensation and rarefaction, or of pathologic condensation and rarefaction. It is of great importance to distinguish between the two, as one of them requires therapeutic interference, while the other prohibits it. To the *physiologic condensations* belong:

(a) The reinforcement of the jaw bone under generally increased

function. A good example is afforded by a case of unilateral mastication, where the difference in density between both sides is remarkable.

(b) The condensation of bone due to change in function. This type of condensation is frequently found in the posterior region of the jaw bone after early extraction of the molars. It is a reaction to the change in stimulation from bending stress (teeth in place) to shearing stress (after extraction of teeth.)

(c) Localized condensation of the alveolar process in places where teeth are in malposition, or receive traumatic occlusal stress of the horizontal type. A smaller part of the alveolar wall functions here to the demand of tension and develops well, while other parts undergo atrophy through disuse or pressure.

The *physiologic rarefactions* are mostly such as are due to lack of functional demand. All cases of physiologic condensation or rarefaction show, in x-rays as well as in slides, a gradual transition from dense to normal bone, which is the main point in differential diagnosis from pathologic condensations. The histological picture of physiologic bone formation shows normal bone with a regular arrangement of haversian systems.

The *pathologic* condensation and rarefaction is produced by the invasion of bacteria and their toxins. The first reaction of the bone is rarefaction, which may here be called resorption. The resorbed area, clearly outlined, is marked off from the normal by a dense variety, which constitutes pathologic condensation and may be called bone of condensing osteitis. This bone presents a histologic picture that distinguishes it from normal bone through the lack or irregularity of haversian systems. This bone is not built for support, but for defense, and tends to protect the jaw from progression of the infection.

Pathologic rarefaction never exists without pathologic condensation. Well known examples are apical areas and cystic conditions. *Pathologic condensation*, or bone of condensing osteitis, is mostly accompanied by rarefaction; sometimes it exists alone, like the condensing osteitis around roots of teeth left in the jaw.

6. STUDIES OF VINCENT'S INFECTION, AT THE CLINIC OF TUFTS COLLEGE DENTAL SCHOOL, FROM OCTOBER 1926 TO FEBRUARY 1928[5]

Francis H. Daley, D.M.D., Dental School, Tufts College, Boston, Mass.
(*Presented by Dean William Rice, D.M.D., F.A.C.D.*)

During a period of seventeen months, 2035 mouths were examined for Vincent's disease, smears obtained, and complete case histories recorded, as patients presented themselves for general operative dentistry. Of this number, 664 (32.6 percent) showed microscopic and clinical evidence of Vincent's infection; and 289 (14.2 percent) had potential infection (that is to say, microscopic evidence of organisms was slight, but clinical symptoms were indicative of the need for treatment to prevent development of infection). The sexes were equally susceptible, and the disease occurred at all ages, whereas pyorrhea is rarely found under thirty-five. Dental caries was almost invariably present with Vincent's infection, whereas with pyorrhea it seems to be latent. A majority of the cases were peculiar in seeming to progress only to a certain point, and then to hold a fairly uniform course over an indefinite period without displaying the symptoms characteristic of true Vincent's angina.

7. NEW EVIDENCE OF MAN'S RELATIONSHIP TO THE ANTHROPOID APES[6]

J. Leon Williams, D.D.S., F.A.C.D., New York City

There are three very distinct forms of human central incisors (Classes I, II, and III), as shown in the accompanying drawing (*fig. 1*). In Class I the proximal sides of the teeth are parallel for one-half or more of the length of the crown. In Class II, the proximal sides rapidly converge from the incisal edge to the cervical or root end of the crown. In Class III a double curve most frequently appears on the distal proximal surface of the crown, but sometimes is seen on the mesial surface, and occasionally on both mesial and distal surfaces. These three classes of central incisors, with minor variations, occur in all racial or people groups, and are *also found, even more strongly marked in their leading characteristics, in the gorilla, orang-utan, and chimpanzee,* in which there are no single tooth forms characteristic of

[5] To be published in an early issue of the *Journal of Dental Research.*
[6] Published in the *Journal of Dental Research,* 1928, viii, pp. 289–321 (April).

anthropoid apes. *There are no racial types of central incisors. Figures 2* to *10*, inclusive, illustrate the general occurrence of the three typal forms of central incisors.

The universal presence, in man and anthropoid apes, of these three types of central incisors—distinctly developed in different morphological directions *yet of little physiological value*—indicates blood relationship rather than accidental homology, and supports the phylogenetic theory that man and the anthropoid apes have been derived from a common ancestor.

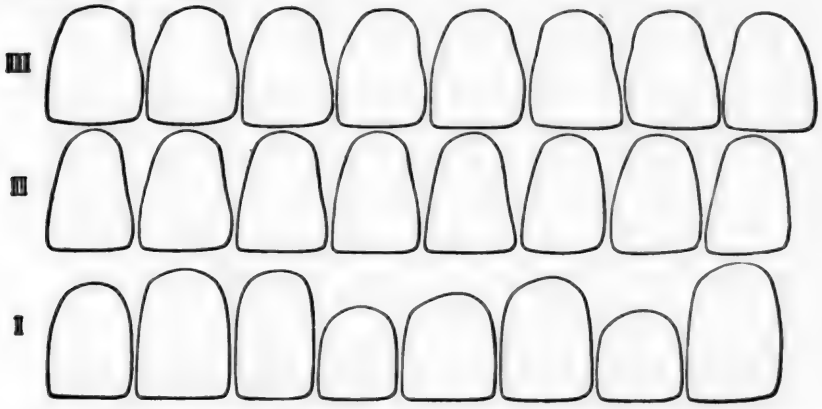


FIG. 1. Accurate drawings from human upper central incisors; slightly enlarged. The Roman numerals at the left indicate the classes.

8. SOME UNIQUE SPECIMENS AND THEIR PATHOLOGY

Frederic James, D.D.S. (Penn.), L.M.M.S.S.A. (Lond.)., Henry Isaiah Dorr Research Laboratory, Dental School, Temple University, Philadelphia, Pa.

The dental practitioner, at some time or other, is confronted with very interesting pathological specimens, some of which are considered more or less as curiosities. By suitably preserving these specimens for study, in small vials filled with 10 percent formaldehyde solution, one is astonished at the information that can be obtained by a critical study of each. To a great number of dentists the word pathology has but little meaning, so that when an abnormal condition is encoun-

FIG. 2. Ancient Egyptian; Class I.

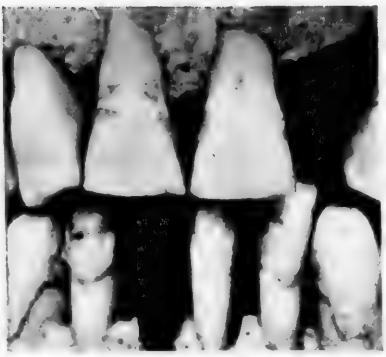


FIG. 5. Modern Italian; Class II.

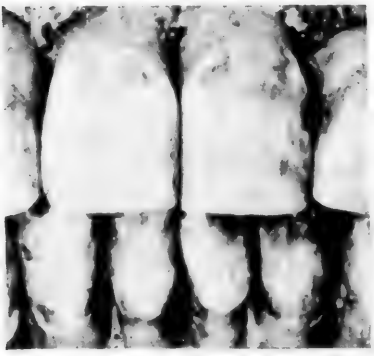


FIG. 3. Tasmanian; Class I.

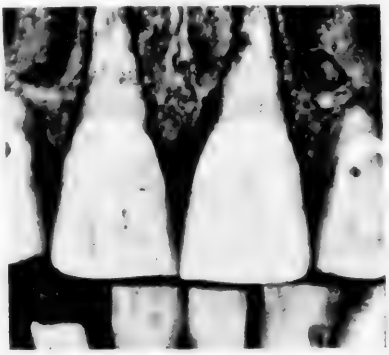


FIG. 6. Tasmanian; Class II.

FIG. 4. Orang-utan; Class I.

FIG. 7. Chimpanzee; Class II.

FIGS. 2–7. Different races of men, and anthropoid apes; Classes I and II.

FIG. 8. Kaffir; Class III.

FIG. 9. Sandwich Islander; Class III.

FIG. 10. Gorilla; Class III.

FIGS. 8–10. Different races of men, and an anthropoid ape; Class III.

tered relative to tooth formation, their knowledge of the subject is very limited. It is for this reason that the twenty-two exhibited specimens were shown.

The principal pathological conditions that proved of interest were the examples of "true" and "false" gemination, ankylosis, dilaceration, supernumerary teeth, compound composite follicular odontome, hyperplasic conditions, and varying degrees of developmental defects. A study of each of these and the other specimens should give the practitioner unlimited information when such conditions present themselves in the course of every-day practice. For this reason is it not correct to aid the dental surgeon along the lines of pathology, and ask him to cooperate with the pathological laboratories so that he may have a better understanding in this field of study? In order fully to understand the basic principles of dental pathology, two aspects of the subject are essential for study: the *macroscopical* appearances—the basis of these exhibits—and the *microscopical* appearance in a thorough examination of the unseen conditions.

9. A PRELIMINARY REPORT OF CASES OF INFECTED VITAL PULPS CAUSING SYSTEMIC DISEASE[6a]

Kurt H. Thoma, D.M.D., Department of Oral Pathology, Dental School, Harvard University, Boston, Mass.

The author first discussed the etiology and pathology of infected vital pulps, especially the types with chronic pulpitis. He showed lantern slides of sections of teeth demonstrating the microscopic changes that may take place. After discussing the bacteriological aspect, he took up the method of diagnosis, which requires careful investigation because, as a rule, there are no subjective local symptoms. He showed slides of roentgen pictures which prove that, by this method, indirect evidence can be demonstrated leading to a diagnosis. This indirect evidence consists of (a) the finding of a cause for pulp infection, such as deep caries, extensive periodontoclasia, etc.; and (b) extension of the inflammation into the periapical area.

The author then reported cases of chronic pulpitis that induced serious systemic conditions, such as, arthritis and other rheumatic

[6a] To be published in the next issue of the *Journal of Dental Research*.

complaints; general toxemia, causing malaise and continued rise in temperature of 1 to 2 degrees; rise in blood pressure in a case of pregnancy; and a case of retrobulbar neuritis with beginning blindness. These cases were permanently cured by removal of the teeth containing the infected pulps. Some of the cases have been followed up for a period of years and show no recurrence.

III. Second Session: Evening, March 25

10. President's Address

Leroy M. S. Miner, D.M.D., M.D., Dental School, Harvard University, Boston, Mass.

Published in full on pages 395–400.

11. Dental Statistics as Collected in Periodical Examination at the Home Office of the Metropolitan Life Insurance Company[7]

Thaddeus P. Hyatt, D.D.S., F.A.C.D., and Alfred Lotka, M.A., D.Sc., New York City

Attention was drawn to the modern movement toward preventive dentistry, and the importance, in connection with this, of studies regarding the characteristic location of vulnerable and of diseased tooth surfaces. Such studies can be carried out effectively and conclusively only by the statistical treatment of many observations on large groups of persons. Opportunity for the gathering of suitable material of this kind presents itself in large institutions, such as schools or commercial and industrial establishments. The report presented at this meeting is based upon examinations of 2943 young men and women, between the ages of 16 and 25, who present themselves for one of the periodical examinations regularly conducted among the employees of the Home Office of the Metropolitan Life Insurance Company.

[7] All examinations, and the work of recording, classification, tabulation, etc., were done in the Home Office of the Metropolitan Life Insurance Company of New York. The complete paper with illustrations will be published in an early issue of the *Journal of Dental Research*.

Dr. Hyatt described some of the details of the methods employed in gathering and working up the data. His remarks were illustrated with lantern slides showing views of the Clinic and equipment, and also some of the machines and apparatus employed, in the Statistical Division of the Company, in tabulating the numerical data. Many charts were shown, which cannot be briefly summarized in abstract. The great preponderance of occlusal defects in molar and bicuspid teeth is one of the outstanding features, which was brought out with great emphasis by the charts. But there are many other facts of equally great importance, the description of which must be reserved for a more detailed report.

12. SYNOPSIS OF SOME WORK ON THE FATIGUE OF CLASP AND OTHER METALS SUBJECTED TO ALTERNATING STRESSES

Marcus L. Ward, D.D.Sc., School of Dentistry, University of Michigan, Ann Arbor, Mich.

The fatigue evidenced in the present clasp metals seems not to differ materially from that shown in other materials when subjected to alternating stress tests over long periods of time, except in the lack of uniformity with which fatigue is shown. This is true not only in clasp metals with complicated compositions, such as those composed of six or seven metals, but it appears also to be true in the simpler ones having four metals. Recent attempts by manufacturers to meet competition in price, and competition in resistance to other stresses, has led some of the manufacturers to introduce six or seven metals into the alloys used for clasp purposes, without consideration for generally recognized sound principles in metallurgy.

In general, it has been impossible, with the microscope, to follow the effect of fatigue in alloys composed of more than three metals. With some of those now furnished to the dental profession, composed of six or seven metals, the exact nature of the fatigue has not been possible to follow. Fatigue with the alternating stress test has been observed much more frequently with the six-metal or seven-metal alloys than with those containing four. Present efforts are being made to improve the technique in casting and heat treatment to allow castings to be made from four-metal alloys giving a somewhat uniform

observation of fatigue. Recently as many as 245,000 alternations have been observed on cast bars of clasp metal 1 mm. in thickness, 2 mm. in width, 25 mm. in length, and held firmly at each end by a clamp that covered 6.5 mm. These bars, after being cast, were carefully dressed to 0.001 inch of the size stated, and were deflected 0.025 inch from a given center determined on the fatigue machine for each piece. Variations in uniformity have been as great as 300 percent, both when the specimens were cooled slowly after being cast, and when chilled quickly after being cast and subsequently heat-treated at 450°C. for various periods ranging from 1 to 5 hours. Up to the present time the highest average number of alternations, before fatigue failure, has been observed when testing four-metal alloys that were cooled slowly after casting. This, however, does not appear to be necessarily the technique to be employed for other alloys, for in some instances a subsequent heat treatment seems to be better.

13. BONE ABSORPTION AND BONE APPOSITION OF THE ALVEOLAR PROCESS

Kaethe W. Dewey, M.D., Department of Oral Pathology, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

A peculiar type of bone is observed on the alveolar process, the significance of which was first indicated by Stein and Weinmann, who described it as "bundle bone." Bundles of fibers, or Sharpey's fibers, are present in the circumferential lamellae all over the alveolar wall, but are masked in ordinary lamellar bone by the calcium impregnation, while in the so-called bundle bone they are plainly visible in sections commonly stained with hematoxylin-eosin, and are made particularly distinct by special stains. This bundle bone of the alveolar process evidently corresponds to bone described by Weidenreich as fiber bone, which is the tissue that is primarily formed in all bones of the embryo and fetus, and subsequently is replaced by lamellar bone. In the adult, fiber bone occurs normally only at the insertion of tendons and ligaments.

The chief value of the investigations by Stein and Weinmann ensues from their observation that development of bundle bone of the alveolar process takes place in adaptation to definite forms of

stress to which the teeth and their suspensory apparatus are subjected. It forms on that side of the alveolar wall where there is traction; while on the opposite side, where pressure is exerted, absorption takes place. It is then a response to movements of the teeth. Bundle bone does not occur about tooth germs, nor retained teeth; nor did Weinmann find it about the erupted teeth of a dermoid cyst of the ovary. Stein and Weinmann believe they observed a tendency of bundle bone to occur on the distal wall of the alveolus, with absorption taking place on the mesial wall; from which they draw the conclusion that, normally, erupted teeth move in a mesio-distal direction, and that the development of bundle bone is a constant normal anatomical reaction. We may surmise that this type of bone develops under all conditions of normal and abnormal stress on the alveolus at the site of traction. Obviously it is the tissue where traction forces are most suitably at play.

Bundle bone, however, was also observed by the author on the outer surface of the alveolar wall, where forced traction can hardly be assumed. In this locality it was usually present when most extensive osteoclasis had taken place on the corresponding inner surface of the bone, and apparently was developed to counterbalance promptly the marked bone destruction. Bundle bone is perhaps the more primitive bone tissue, and forms more rapidly than lamellar bone. These two manifestations of prompt response on the part of the alveolar bone, in following up traction by bundle-bone formation and yielding to pressure by osteoclasis, are the outstanding characteristics of the alveolar process. They bring about that remarkable plasticity and adaptability of this bony structure which is so largely relied upon by the orthodontist, as the relatively very great stability of the teeth is a matter of equally great comfort to him.

14. A REVIEW OF THE MOST RECENT RESEARCH ON MOTTLED ENAMEL[8]

Frederick S. McKay, D.D.S., New York City, and Grover A. Kempf, M.D., Bureau of Child Hygiene, Washington, D. C.

This report was presented in the form of a brief outline of the investigation of mottled enamel from its beginning in 1907 to the present

[8] To be published under the auspices of the U. S. Bureau of Child Hygiene. See abstract no. 28.

time, indicating the geographical distribution of this lesion and illustrated by lantern slides showing, so far as possible, a typical case from each of the districts in which it occurs. The most recent work was done in February, 1928, in a community in one of the Southwestern States, in which an endemic percentage of 100 was found among the natives who had used the city supply of water from artesian wells during the period of enamel development. Several typical cases from this district were illustrated. One very important result of the investigation, as affecting this community, has been the abandonment of the artesian source of municipal water supply and the installation of a new supply from a source known to be associated with normality of the enamel in a neighboring community. This is the second community in the United States in which a municipal water supply has been discarded solely because of the demonstrated relation of mottled enamel to the water, the first having been Oakley, Idaho, as published in *Dental Cosmos* in September, 1925.

15. FATTY CHANGES IN THE TOOTH AND INVESTING TISSUES[9]

Edward H. Hatton, B.L., M.D., Dental School, Northwestern University, Chicago, Ill.

Without using stains, Wedl noticed fat droplets in the pulps and dentine of diseased teeth. Frozen sections of teeth may be studied with fat stains in solutions having no solvent action on fat. Using such methods, the author and other workers have observed that deposits of free fat are constantly found in the dentinal tubules of carious teeth, and in other conditions in the pulp. Such deposits occur in odontoblasts and in nerves, where they precede calcification, and also in granulomas and in the peridental membrane.

IV. Third Session: Evening, March 26

16. DEVELOPMENT OF TEETH[10]

B. Orban, M.D., Department of Histology and Pathology, Chicago College of Dental Surgery, Dental Department of Loyola University, Chicago,

[9] To be published in an early issue of the *Journal of Dental Research.*

[10] To be published in the author's forthcoming book on dental histology.

Ill. (*Investigation made in the II Anatomical Institute of the University of Vienna, Professor F. Hochstetter, Director.*)

The first appearance of tooth development is a thickening of the mouth epithelium (human embryo 13 mm. in length). At 16 mm. the tooth germs appear as thickenings of the mouth epithelium. A dental lamina forms simultaneously with the growing tooth-germ. In the beginning no dental lamina exists; then the tooth-germs appear on the end of the dental lamina; later they come to lie on the labial side of the lamina. This change in the relationship between the lamina and the tooth-germ is due to an incongruence in growth between the different portions of the tooth-germ and the surrounding tissues.

At a stage over 30 mm. in length (human embryo) an epithelial strand (described by Bolk) develops on the labial side of the tooth-germ and the dental lamina, which gives a double connection between the tooth-germs and the mouth epithelium. During growth two niches develop between the dental lamina, tooth-germ, and lateral enamel strand. One of these niches opens toward the middle line of the jaw, and is to be seen only in sections cut frontally. In series cut sagitally, the second enamel niche appears, which opens distally. The mesial niche has been described by Bolk. The distal niche was described by the author, who believes that the appearance of the niches and lateral enamel strand is an indication of the separation of the tooth-germs from the dental lamina.

17. BACTERIAL DESTRUCTION OF THE ENAMEL

Charles F. Bödecker, D.D.S., F.A.C.D., Dental School, Columbia University, New York City, and Henry W. C. Bödecker, B.S., D.D.S., M.D., D.M.D., Berlin, Germany

For over half a century investigators have attempted to isolate the bacteria responsible for dental caries. It has now become possible, by the use of special methods, to show and possibly identify the type of bacterium in the act of destroying one part of the enamel.

Enamel is destroyed during dental caries by two agencies: (a) decalcifying acid formed probably by Bacillus acidophilus; (b) proteolytic enzyme from bacteria (probably strepto- or diplo-cocci),

which digests the protein in the enamel.[11] The selectivity shown by the proteolytic bacteria, in destroying the content of the enamel rod more quickly than the enclosing enamel-rod sheath, suggests that these two structures differ chemically. In the opinion of the authors, the sheaths are composed of keratin and the rod of calcified protoplasm.

18. INTRINSIC OR HEREDITARY FACTORS VERSUS EXTRINSIC OR ENVIRONMENTAL FACTORS IN THE DETERMINATION OF TOOTH AND ORAL PECULIARITIES[11a]

J. A. Detlefsen, A. M., S.D., Wistar Institute of Anatomy, Philadelphia, Pa.

The author presented the details of a method of analysis whereby the knowledge of certain causal relations can be combined with the knowledge of the degree of correlation between pairs of genetically related individuals, to determine the influence of hereditary constitution and various groups of environmental factors. The materials used were observations on teeth and arches of thirty-five pairs of identical twins, and such data or measurements as are presented in the literature from other similar cases and from fraternal twins. The method may be extended to a study of occlusion, caries, size and form of teeth and arches, gingivitis, or any other feature of dental anatomy or physiology capable of satisfactory measurement or gradation. With all the reservation which should attach to conclusions from small numbers of isolated clinical observations, one can nevertheless say that the separate features or attributes of dental anatomy, physiology, and pathology are not determined to an equal degree by the same antecedent causes. While tooth shape and size, and arch shape and size, are apparently largely determined by hereditary constitutional causes, incidence of caries of the permanent teeth was apparently largely determined by environmental variations.

It is regrettable that on a matter of such far-reaching importance to

[11] Bödecker: The bacterial invasion of the enamel in dental caries. *Dental Cosmos*, 1927, lxix, p. 987.

[11a] To be published in the *International Journal of Orthodontia, Oral Surgery, and Radiography*.

orthodontia and dentistry in general, a conclusive answer cannot be given, although it is clear that the data are available in the general population, and the methods of analysis offer a solution.

19. NUTRITIONAL ASPECTS OF PYORRHEA

Sherman L. Davis, M.A., Ph.D., Dental School, Indiana University, Indianapolis, Ind.

Pyorrhea patients may be grouped under two heads: (a) those who are apparently well nourished, and (b) those who are not. Persons with normal or excess weight may be, and usually are, heavy eaters who consume large amounts of proteins and carbohydrates. When such habits are continued over long periods, the body cells suffer many modifications. This is due in part to the lack of adequate amounts of the accessory foods in the diet, diminished alkalosis, and unnatural demands on the body cells, and is illustrated in the case of ingestion of excess of protein.

The body of an adult requires a maximum of 70 gms. of protein daily. Heavy consumers of meat use much more. The body makes no provision for storing protein in excess of its needs. Hence any excess is deaminized in the liver, after which it is either changed to fat and stored, or changed to butyric acid and subsequently burned to carbon dioxide and water. Some of the fat is stored in the alveolar and secretive tissue of the liver, reducing its deaminizing power, and leading to the formation of abnormal amounts of such substances as guanidin, creatin, uric acid, etc. It is not uncommon to find these substances as much as 15 percent in excess of normal. They favor the formation of serumnal calculi at the crest of the alveoli, many such calculi being made up of uric acid, acid urates, phosphates, etc.

The shortage of vitamins may favor the formation of salivary calculi, because vitamins are necessary for calcium metabolism; and salivary calculi are but an expression of the body's failure to metabolize it properly. Such calculi lead to constant irritation of the gingivae, thus presenting a favorable condition for streptococcal infection, usually dominant in pyorrhea.

Pyorrhea may be acute or chronic. *Acute pyorrhea*, i.e., inflammatory and of short duration, is associated with definite nutritional

syndromes, such as (a) high blood calcium, (b) high blood sugar, (c) low alkali index. High blood calcium and sugar indicate that nature is speeding up nutritional processes to combat the streptococcal invasion. The high blood calcium favors the activity of the polymorphonuclears, the natural phagocytic cells in the blood. Dr. Price has pointed out that a low alkali index (manifested by a mild acidosis) causes the body rapidly to absorb the alveolus to supply the depleted lime which is necessary for the phagocytic action of the polymorphonuclears. The increase in guanidin, creatin, and similar metabolic products also lowers the alkali reserve, because they hinder mineral metabolism. The absence of a normal amount of vitamin B is another factor of importance. When it is deficient, enzymes such as oxidases, glyoxalases, etc., are reduced much below normal amounts, and normal metabolism cannot take place. Its absence also favors bacterial invasion.

Chronic pyorrhea, i.e., pyorrhea of long duration, is usually associated with definite nutritional syndromes, such as (a) low ionic blood calcium, (b) low alkali index. Low ionic calcium may be due to food habits that make calcium assimilation difficult, or to the slow absorption of toxins from pus pockets or carious teeth. Low ionic calcium means weak resistance to infection, and a general nutritional insufficiency.

20. CHRONIC OSTEOMYELITIS OF MAXILLA AND MANDIBLE[12]

Sterling V. Mead, D.D.S., Departments of Oral Surgery, and Diseases of the Mouth, Dental and Medical Schools, respectively, Georgetown University, Washington, D. C.

This paper is the result of the study of a series of one hundred cases of a phase of chronic osteomyelitis of the mandible and maxillae which has apparently been overlooked, wherein the peculiar type of bone pathology has occurred spontaneously, and has not been the result of a preexisting acute condition. Therefore, it differs materially in etiology, symptoms, and treatment from the ordinary chronic osteomyelitis resulting from acute conditions.

[12] Published in the *International Journal of Orthodontia, Oral Surgery, and Radiography*, 1928, xiv, p. 321.

Chronic osteomyelitis is caused by portions of broken-off roots, impacted teeth, unerupted teeth, foreign bodies, infection residual in the bone after the removal of the cause, or any form of irritation or low grade infection. Chronic osteomyelitis is characterized by long continued inflammatory process, with alternating areas of bone destruction and bone formation. In some cases the disease is confined to rarefaction of bone. The process is insidious, and the symptoms are usually so slight or so ill defined that the patient is not aware of any pathology. Attention is usually drawn to this type of bone disease by a bulging or swelling on the buccal or lingual plate, or by subjective symptoms. The patient may complain of indefinite pains radiating to the ear, or a dull uneasy sensation in the particular region involved. In some cases the throat or maxillary sinus may give symptoms of inflammation or even suppuration, or there may be excessive mucous discharge without any apparent cause.

21. STUDIES ON INORGANIC SALT METABOLISM. VII. THE EFFECT OF FAULTY DIET ON THE DENTITION OF BROOD BITCHES, AND THE DENTAL AND SKELETAL DEVELOPMENT OF THEIR OFFSPRING[13]

Martha R. Jones, Ph.D., Department of Pediatrics, University of California Medical School, San Francisco, Calif.

Observations were made on six brood bitches and thirty-eight newborn puppies. Mothers and offspring were divided into two groups. In Group 1 were four large, mongrel bitches (Nos. 5, 7, 8, and 9) and twenty puppies. All of the bitches and the male with whom they were mated (Dog 1) lived under identical conditions of diet and hygiene. They received a negligible amount of ultraviolet radiation, and for varying lengths of time before mating were fed quantitatively on a diet consisting of 75 grams of lean, ground beef (cooked); 225 grams of finely ground, patent flour, wheat bread; 600 grams of white potato (peeled and boiled); and 5 grams of sodium chloride—all made into a mash with distilled water. The daily diet furnished approximately 1560 calories, 59 grams of protein, 0.15 gram of calcium, 0.72 gram

[13] Aided by grants from the W. H. Crocker Fund for Research in Pediatrics, and from the California Stomatological Research Group. To be published in an early issue of the *Journal of Dental Research.*

of phosphorus, 3.0 grams of potassium, and an excess of base equivalent to approximately 13 cc. of normal solution. Two of the bitches (Nos. 8 and 9) that received, in addition, increasing amounts (0.75 to 4.0 grams) of anhydrous sodium carbonate daily, were not successfully bred, although both had previously given birth to two litters. Dental tissue excised from these animals, after they had been on the alkaline diet for 130 days, showed profound degenerative changes in the roots of the teeth and alveolar bone.

Three successive litters, which were born to *Bitches 5 and 7* during a period of two years, showed increasing proneness to skeletal disorders. The father of all six litters was Dog 1. All three animals received a negligible amount of *ultraviolet* radiation, and were fed continuously for two years on a stock diet consisting essentially of bread, meat, and potato. Continuation of the dietetic and hygienic regimen had no effect upon the number of individuals in a litter. The total weights of the litters, as well as weights of the various individuals differed greatly. The puppies killed at birth had a low percent of mineral in their bodies and faulty bone structure. The body ash varied from 1.87 to 2.5 percent and that of the bones from 4.7 to 13.2 percent. The mineral content of the fresh body substance of the last litters (born during the period of quantitative feeding) showed a further decrease, the values in the offspring of Bitch 5 averaging 1.73 percent; in those of Bitch 7, 2.09 percent. The total weights of these litters were markedly less than of those preceding, and differed by only 35 grams. The amount of bone ash in the offspring of Bitch 7 varied from 7.8 to 10.4 percent, the average being 9.4. The bone structure was abnormal and differed in the various individuals. Histologic examination of dental tissues showed disturbances in both enamel and dentin forming mechanisms. Both bitches had convulsions during their last pregnancies, and died at the time of littering. Dental tissue excised post-mortem showed degenerative changes in the roots of the teeth and alveolar bone. The oral conditions and degree of involvement of the dental tissues differed in the two animals. Their metabolism also differed—the mineral content of the body substance of representatives of the litters born to Bitch 7 being invariably higher than that of the offspring of Bitch 5, which were born at about the same times and under the same dietary and hygienic conditions.

In Group 2 there were two bitches (Nos. 28 and 31) and 18 puppies. Eight of the puppies were offspring of bitches whose histories and dental conditions were unknown. Bitches 28 and 31 had lived in the kennels for six weeks and one year, respectively, before the birth of young, and during that time were fed on a stock diet of bread and meat. The foods were roughly measured in about equal amounts of weight. This diet contained more protein, but less carbohydrate, vitamin, calcium, and potassium than the diet for Group 1, and was relatively high in potential acidity.

Bitch 28 was a large, apparently normal, mongrel terrier. Her early history and mate were unknown. Her oral condition was good, and she suffered no apparent dental deterioration during pregnancy. On April 1 she gave birth to a litter of eight apparently normal puppies, half of which were killed at birth. The behavior of those left with the mother proved to be comparable to that of the offspring of the average "street" dog, and findings on two of the new-born puppies in this litter have arbitrarily been chosen as standard. The mineral content of their bones averaged 14.45 percent. No striking abnormalities were noted in the long bones or ribs. As was found in the dental tissues of puppies in Group 1, there appeared to be a disturbance in the layer of ameloblasts. On the whole, histologic findings were in striking contrast to those observed in the offspring of Bitches 5 and 7.

The oral condition of *Bitch 31*, when she arrived at the kennels, was extraordinarily poor in spite of the fact that her physical condition was excellent. She had lived on a ranch all her life, and had been fed on a mixed diet (largely vegetables) with raw, skimmed milk *ad libitum*. Her mouth presented a clinical picture of pyorrhea. The upper canines were missing. Small fragments of roots remained in situ. Tissue excised for histologic study showed profound degenerative changes in the alveolar bone, which indicated that the roots of the teeth had been resorbed. After one year in the kennels on a diet of bread and meat, the bitch gave birth to a litter of six small, poorly nourished puppies. Mother and new-born offspring were killed. A post-mortem dental examination of the bitch showed disintegration of the crowns of nearly all of the teeth. Dental tissue corresponding to that excised twelve months previously was examined, and the histo-

logic picture found to be markedly different from that observed in the biopsy tissue. There was less lacunar resorption, the pulp was less fibrous, and the peridental membrane was much narrower, than in the biopsy material. The alveolar bone also presented a different appearance. Haversian systems throughout the process were embedded in a matrix of fibers from which the inorganic constituents appeared to be leached. This striking condition was also observed in the post-mortem dental tissues of Bitches 5 and 7, and may be associated with pregnancy. The mineral content of the bones of the new-born puppies varied from 11.1 to 16.1 percent, with an average of 14.06. The histologic findings in the bone and dental tissues were, on the whole, comparable to those observed in the corresponding tissues of the offspring of Bitch 28, which were chosen as standard.

No relationship could be established between the weight of the puppy and the degree of calcification or structure of its bones and teeth in any of the litters. Greater structural differences were found in the ribs than in the long bones or dental tissues.

The experiments reported in this paper are preliminary, and are not sufficiently numerous or varied to warrant deduction in regard to the mechanism of foetal calcification. They show however, that puppies may be born with mineral deficiencies and structural defects in bone and dental tissues. It has furthermore been demonstrated that different combinations of common food-stuffs exert markedly different effects upon the dentition of brood bitches, and the dental and skeletal development of their offspring.

22. COLLECTION OF DATA RELATIVE TO EDENTULOUS PATIENTS, AND ITS VALUE IN RENDERING DENTURE SERVICE

Walter H. Wright, D.D.S., F.A.C.D., Department of Clinical Prosthesis, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

The problems incident to rendering denture service are many and varied. In one group we find the most profound problems of engineering and its allied sciences, while in another we are confronted with biologic problems quite baffling in character. When we consider that the teeth of man were intended to render service over the life span, but that modern civilization has greatly shortened this service,

and further, that the remnant of the bony foundation surviving the loss of natural teeth was never intended to support artificial restorations, we can form some idea of the magnitude of the problems which confront those who work in this field.

A definite procedure has been employed in the collection of data pertaining to this work. Measurements of the structures in question together with notations as to the condition of the tissues are recorded. The measuring equipment consists of a specially constructed caliper with a millimeter dial, a protractor, a millimeter gauge, and study models of the patient's jaws. A suitable chart permits a record of data including the size, form, and relation of the jaws and associated structures; the condition and distribution of mucosa-supporting tissues of the denture area; measurements showing the relation and proportion of facial features, besides general information including age, sex, health, nationality, date of extractions, former service with dentures, color of hair and complexion, and shade, form, and size of artificial teeth. An exact record of the technical procedure, results at the time of insertion of the restoration, results during the following month and in many cases over a period of years, is kept.

Many problems have arisen, some of which have been solved, others are being investigated, while many await attention in the future.

23. DENTIFRICES

Charles F. Bödecker, D.D.S., F.A.C.D., Dental School, Columbia University, New York City

Two kinds of ingredients sometimes found in dentifrices may do considerable harm to the enamel. They may be classed as (a) the acid group and (b) the gritty group.

Acid group. Some acids readily remove salivary calculus and stains from the teeth and thus whiten them temporarily. The use of such acids, however, not only achieves this result, but also may destroy the surface of the enamel, thus making it more prone to decay.[14]

Gritty group. Gritty ingredients also readily remove stains from teeth, but they too are injurious to the enamel, particularly if the grit is harder than the enamel.

[14] Bödecker: Effects of "Taxi" and of "Stain Remover," so-called toothcleaning fluids, on dental enamel. *Journal of Dental Research*, 1927, vii, p. 480.

Lymeogene Tooth Powder contains microscopic, exceedingly sharp-pointed crystals, presumably of a silicious nature, which are harder than enamel. It is therefore a foregone conclusion that such sharp pointed crystals in a dentifrice will be harmful to enamel. This was practically demonstrated by brushing a glass slide for ten minutes with a tooth brush charged with Lymeogene, the result being appreciable scratching of the surface.

24. THE CEMENTUM CUTICLE

Harold Keith Box, D.D.S., Ph.D., F.A.A.P., Dental School, University of Toronto, Toronto, Canada

The cementum cuticle is a thin, homogeneous, keratinized layer formed by the crevicular epithelium during its proliferation along the cementum to cover the detached connective tissues. It holds for a time the cementum and the soft tissues in a state of organic union. With the separation of the epithelium from the root, this translucent pellicle remains, as a rule firmly adherent to the tooth. It is continuous with that important component of Nasmyth's membrane, the secondary enamel cuticle of Gottlieb, and is its histologic counterpart. As it is formed in the same manner on the surface of the root as on the surface of the crown, Gottlieb has termed this layer in its entirety, "cuticula dentis." Weski confirms the existence of this dental cuticle, and has termed it "epithelial cuticula," and further, has divided it into a crown-part, "enamel cuticula," and a root-part, "cementum cuticula." This division, from a topographic standpoint, makes for clarity in periodontal nomenclature and teaching. It would appear, therefore, that this distinction, in addition to the fact that the term "cuticula dentis" is commonly though incorrectly used as a synonym for Nasmyth's membrane, presents obvious advantages in the anatomic division of the dental cuticle. Through its peculiar physical and chemical characteristics, the cementum cuticle becomes at once a most important protective medium for the cementum. Its close adaptation to the root-surface, its toughness, and its special resistance to strong acid and alkaline solutions, endow it with distinctive defensive qualities; and unquestionably the cementum is greatly protected thereby from the fluids and bacteria of the pocket.

V. Fourth Session: Evening, March 27[15]

25. Nutrition and Health of the Labrador Eskimo, with Special Reference to the Mouth and Teeth[16]

Leuman M. Waugh, D.D.S., F.A.C.D., School of Dentistry, Columbia University, New York City

It is generally believed that the primitive Eskimo has the best teeth of any known human race, either civilized or savage. Direct observations among the Labrador Eskimo at Hopedale and Makkovik, with the aid of missionaries and local officials, indicate that this belief is erroneous. In these settlements, where for two or three decades carbohydrate has constituted approximately 50 percent of the diet, protein and fat having been correspondingly reduced to about 25 percent each, the teeth were found to be in a deplorable condition; and they appear to be getting worse in each succeeding generation. Teeth in some of the Eskimo, under twenty years of age, were decayed to the gum line, and the roots further hollowed out by caries. Alevolar abscess with sinus was common. Some of the old natives had very good teeth.

In other groups of Eskimo, about Hebron, on a diet having much smaller proportions of carbohydrate and higher percentages of protein and fat, the dental conditions were much better—in some nomadic groups farther north, in the Port Burwell region, the teeth were practically free from decay. But there was gingival disturbance in practically every individual of twelve years and over, owing to an abundance of flint-like deposits of calculus that encroached upon the supporting structures until in old age this was the greatest factor in the loss of teeth.

Lack of constancy in the form and presence of the third molar was notable. A number were rudimentary in size, and in some mouths one or two were either congenitally absent or had never erupted.

[15] Dr Waugh's study (25) was presented at an informal dinner of the members and guests before the opening, in the same hotel, of the evening session of the American Association of Dental Schools, at the conclusion of which the session of the Research Association was resumed in the room vacated by the School Association (Chinese Room). During the afternoon, the members were the guests of the National Bureau of Standards, where the equipment and work in progress in the various buildings were shown and explained.

[16] To be published in an early issue of the *Journal of Dental Research*.

The observations warrant these general conclusions:

(a) The health of the Eskimo is rugged and his teeth, despite much inbreeding, are excellent while he lives the nomadic life of his ancestors.

(b) He is best nourished by his native food, consisting of protein and fat exclusively. This, frozen solid for about nine months of the year, is eaten almost entirely raw.

(c) In the so-called "civilized" settlements, where he adopts the white man's food, clothing, and mode of housing, and is exposed to the white man's diseases, there is a marked lowering of physical prowess in the younger generations.

(d) He is susceptible to epidemics to an alarming degree.

(e) Before the Eskimo can successfully associate with and adopt the civilization of white men, his resistance against our diseases will have to be increased.

(f) The Eskimo jaws and teeth continue to be the largest, strongest, and least carious of any known race, wherever he subsists strictly on native foods.

(g) In localities where carbohydrate food is available, he eats it in great quantities, reducing the intake of protein and fat, and the teeth decay rapidly, with consequent serious alveolar abscesses and grave systemic sequelae.

(h) Heavy deposits of calculus are present in the mouths of practically every Eskimo after ten to twelve years of age, resulting in periodontal disease ranging from a mild chronic hyperemia to nearly total destruction of the supporting structures of the teeth. Almost no pus is observable in this condition.

26. ANALYSIS OF STATE DENTAL BOARD EXAMINATIONS IN THE UNITED STATES, WITH COMPARISONS OF FAILURES OF RECENT GRADUATES[17]

F. C. Friesell, D.D.S., F.A.C.D., Dental School, University of Pittsburgh, Pittsburgh, Pa.

The publication of inaccurate tabulations of the failures of recent graduates in state board examinations having been an injustice to dental colleges, an agreement was entered into by the national asso-

[17] Published in this issue: *Journal of Dental Research*, 1928, viii, p. 387.

ciations of colleges and of examining boards in the United States whereby certified lists of graduates were furnished by the former and correct examination data by the latter. General rules for tabulation were adopted; coöperative tabulation committees were formed; tabulations were audited, corrected if necessary, and approved for publication. Under the new plan, annual tabulation—covering eighteen years and including forty-one existing schools, forty-eight states, and the District of Columbia—has been conducted without friction.

Some interesting data were presented for the years 1910–27, inclusive, relating to the schools in this country. The total number of graduates of 62 schools was 44,700. Of this number, 38,682 were examined, 5,277 failing at the first trial. During this period 21 schools were discontinued. Of the 33,212 graduates of the 41 surviving schools who were examined, 4,150 failed—12.5 percent of failures. Of the 5,470 graduates of the 21 defunct schools who were examined, 1,127 failed—20.6 percent of failures. The proportions of failures for individual schools varied from 0.8 percent to 30.4 percent; in the examinations in the individual states, failures ranged from 1.4 percent to 68.3 percent. The average proportion of failures of a school's graduates in the home state was 8 percent; in other states, 24.2 percent. In the United States, in 1927, there were 2,642 graduates in dentistry, of whom only 2,412 were examined by state boards, 2,210 having passed, 202 having failed—8.4 percent of failures as against the cumulative average of 12.5 percent for the same schools in the eighteen-year period.

27. DIAGNOSIS OF PERIODONTOCLASIA[18]

F. V. Simonton, D.D.S., California Stomatological Research Group; Dental School, University of California, San Francisco, Calif.

The essential causes of caries must be found in conditions common to widely variant forms of animal life, both feral and domestic, although domestication and civilization have profoundly increased the incidence of etiologic factors. The Rhodesian skull shows marked carious and

[18] To be published in the next issue of the *Journal of Dental Research.*

pyorrheal destruction. This fossil was found at the Broken Hill mine in Northern Rhodesia, Africa, in 1921. It is supposed by Sir Arthur Keith to be related to Neanderthal man. If convincing evidence is forthcoming that true pyorrhea does not occur in wild animals in their native states, then this disease will be restricted wholly to man (fossil and modern) and to domesticated animals, while dental caries will not be so restricted. It may be concluded that since dental disease, both caries and pyorrhea, did occur in primitive and even in prehistoric man, the causes of dental disease are not, therefore, exclusively concomitant with civilization or the use of cooked foods. Dental disease, however, has been enormously increased as a result of civilization. Dental disease occurs and can be experimentally induced in the lower animals.

It seems not to be doubted that dental characters (such as blue teeth) are inherited (in Mendelian ratio). It seems probable that susceptibilities to periodontoclasia are or get into the inheritance (1) possibly through slow (artificial) selection (reversal of evolution through preservation of the unfit); (2) possibly through inherited variations in tissue chemistry, such, for example, as lead to the necessity for blood groupings. Susceptibility of chemo-structural variants to acquired irritants might in this case be quite fortuitous. There is no doubt that individuals showed different resistance to pyorrhea when first the species became afflicted with this disease. There is no good reason to suppose that these individual degrees of resistance might not be transmitted.

The fact that chemically and bacterially *materies alba* is irritating, and the close correlation of *materies alba* with inflammation, together with the fact that in many cases the persistent removal of debris relieves the inflammation, justify the diagnosis of many cases of superficial parodontitis as due to stagnation. But inflammation of the gingivae may occur without the presence of debris; and so, while stagnation is one cause, it is not the only etiologic factor.

Superficial gingivitis may be produced by purely endogenous causes. Non-infectious inflammations may occur; e.g., possibly analogous to angioneurotic edemas. Alternative conjectures are infection by filtrable viruses or non-invading surface pathogens.

Following gingivitis may occur either horizontal or vertical involve-

ment of the deeper tissues. It would seem that the horizontal type is merely the sequel of chronic gingivitis uncomplicated by susceptibility. Horizontal paracementitis of purely local origin is well illustrated by sialocalcic periodontoclasia. It is the sequel of sialocalcic gingivitis. A type case has been described in detail in a paper entitled "The etiology of parodontoclasia." In this case the etiologic factor was accretion of salivary calculus due to disuse. The result was a slow wasting away of the parodontia at right angles to the long axes of the teeth.

Intermediate between the horizontal and vertical forms is the clinical type: sulcicalcic periodontitis. This condition is characterized by relatively shallow pockets, generally less than 4 mm., and deposits of calculus within the pockets. The inflammation is intense, the gingivae and alveolar mucosa swollen and engorged, and resistance active. The etiologic factors are inflammation, combined with dehiscence, which is a splitting away of the soft tissues from the teeth, related to downgrowth of epithelium.

In cases where the tissues are unable to oppose sufficient resistance to exogenous irritants, or where local endogenous or systemic susceptibilities exist, vertical extensions may occur. Microscopic study reveals two possible pathways for the spread of inflammation from the gingivae. One is along the pericementa, the other through the bone marrow. I am of the opinion that, where obvious local factors are not present, these extensions are due to endogenous factors.

Of all the types of periodontoclasia, that characterized by a resorption of the alveolar process without the necessary presence of any inflammation has been most obscure. In this country investigators as well as clinicians seem to have overlooked it, in spite of the fact that it constitutes a definite and easily recognizable entity, is not at all rare, and seems to merit attention as a result of the writings of Talbot and Hopewell-Smith. Gottlieb has described the histologic picture of this condition under the head of diffuse atrophy, and reached the conclusion that it is of systemic origin but not related to any systemic disease. Evidence that this condition may be produced experimentally in the dog, due to a disturbed acid-base balance of the diet, has been advanced in an earlier publication.

The studies of Gottlieb have shown that the gingival sulcus (pocket,

as he calls it) is an entity different from that previously understood. As the tooth erupts, it carries with it the remains of the enamel organ (an epithelial structure). When this reaches the epithelium it coalesces with it. As the tip of the tooth appears at the surface an opening is formed. At this time the epithelium of the mucosa is continuous with the remains of the enamel organ (Nasmyth's membrane) and the latter is securely affixed to the enamel. There is no sulcus. As the tooth moves upward into occlusion a dehiscence of the gingival epithelium from the enamel cuticle takes place, and this dehiscence forms the true sulcus. Previously it had been thought that, when the crown of the tooth came into occlusion, eruption was complete and the bottom of the sulcus was at the gingival line. Through studies of monkey, coyote, and opossum tissues, we have recently obtained confirmatory evidence of the physiologic nature of the cemental *Epithelansatz* in the region of the neck of the tooth.

28. AN INVESTIGATION OF MOTTLED ENAMEL IN AN ENDEMIC DISTRICT IN ITALY[19]

Frederick S. McKay, D.D.S., New York City

A reference to the existence of a district adjacent to Naples, Italy, that was endemic to mottled enamel was first published by Captain J. M. Eager of the U. S. Marine Hospital Service (*Dental Cosmos*, 1902, March). This is believed to be the original allusion, in dental literature, to this lesion.

The examination alluded to in this report was made in August, 1927, in the city of Resina, a few miles south of Naples, where it was found that mottled enamel had formerly been produced among those of the inhabitants who used water from certain wells but, since the abandonment of these wells several years ago, and the substitution of a municipal supply drawn from a distant source, further production of mottled enamel has ceased. That is to say, certain adult natives who used water from these wells during childhood exhibited mottled enamel, whereas the present generation of children is free from it. On the other hand, just outside the city the occurrence of the lesion, among

[19] Read by title at a meeting of the New York Academy of Dentistry, Hotel Commodore, March 22, 1928. Published in this issue: *Journal of Dental Research*, 1928, viii, p. 353.

the adult natives and also the present generation of children, was found to be associated with the use of water drawn from surface wells. Without exception, all persons who used such water during the period of enamel development exhibited mottled enamel.

It is interesting to note that the city of Resina is situated directly above the city of Herculaneum, which in 79 A.D. was buried by lava from Mount Vesuvius, and that the water in these wells has percolated through the underlying lava.

29. EFFECTS OF CERTAIN ASTRINGENTS ON THE ORAL MUCOUS MEMBRANE

Thurlow W. Brand, B.S., D.D.S., School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

The dogs used in these tests had been etherized for previous experiments on the submaxillary gland. The influence of the ether and of the previous experiment had a definite bearing upon this work, as the pulse rate was increased and hyperemia was induced. At various regions on the oral mucous membrane, solutions of different strengths of *zinc chloride* or of a *dental prophylactic* were applied for *ten* minutes. Two regions, not treated, were used as normal controls.

I. The histologic findings for the *untreated areas* were (a) dilation of superficial blood vessels; (b) regional congestion; (c) extravasation of erythrocytes in several places. The findings for the areas treated with *zinc chloride solutions* were these: *1 percent solution*—(a) capillary dilation; (b) slight decrease in tissue congestion; *5 percent solution*—(a) blanching of the surface layer of the membrane; (b) coagulation of the cell contents of this layer; (c) decreased congestion; (d) slight constriction of capillaries; *10 percent solution*—(a) further decrease in congestion; (b) more marked constriction of capillaries; (c) a few capillaries showed thin walls, as if the endothelial cells had been elongated; *20 percent solution*—(a) marked capillary constriction; (b) stratum corneum of the membrane surface indicated coagulation of cell contents.

II. The findings for the areas treated with the *dental prophylactic solutions* were these: *10 percent solution*—(a) congestion of blood vessels; (b) dilation of capillaries; (c) thin walls of capillaries showed

stretched endothelial cells; (d) extravasation of erythrocytes in many regions; *20 percent solution*—(a) slight dilation of vessels; (b) capillary walls normal; *50 percent solution*—(a) slight constriction of the capillaries; (b) no congestion.

III. A series of experiments on dogs similar to those in sections I and II, above, using the same dilutions but applied for only *five* minutes, showed analogous results, but the degree of constriction was less, and the changes in the caliber of the vessels were not so great.

IV. The application of *zinc chloride* upon the *web of a live frog's foot* gave these results: *20 percent solution*—(a) increase in the rate of blood flow; (b) constriction of the blood vessels; (c) marked erythematous condition; *10 percent solution*—(a) moderate increase in rate of blood flow; (b) slight constriction of vessels; *5 percent solution*—(a) slight increase in rate of blood flow; (b) hardly any vascular constriction; *1 percent solution*—apparently no effect on (a) size of vessels, (b) or rate of blood flow.

V. The application of *zinc chloride* in solutions of various strengths, to the *skin of the abdomen of a living unanesthetized frog*, showed histologic conditions similar to those in the oral mucous membranes of the dogs in the first three groups of tests. The stronger the concentration of zinc chloride solution, the more marked the constriction of the vessels, and the less congestion.

30. A QUANTITATIVE EXAMINATION OF THE MOUTH FLORA UNDER DIFFERENT DIETARY CONDITIONS[20]

Beatrice F. Howitt, M.A., and Willard C. Fleming, D.D.S., California Stomatological Research Group, and Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Calif.

A quantitative examination of the mouth flora was undertaken on about eighteen men in the State Prison at San Quentin, California. The men were divided into groups according to whether their mouths were normal, or had varying degrees of pyorrhea of either the inflammatory or the non-inflammatory type (Simonton's classification).[21]

[20] To be published in an early issue of the *Journal of Dental Research*.

[21] Simonton, F. V.: Pyorrhea—definition and classification. *Dental Cosmos*, 1926, lxviii, p. 158.

A group of each was placed on a predominantly carbohydrate diet, and another on a predominantly protein fare, over a period of several months. Later the diets were reversed, in most cases for a shorter time. These fares had been selected by Dr. Martha R. Jones for use in metabolic studies on a number of the same men, and were of such a nature that the urinary reaction averaged about 5.7 pH in the men on the acid protein diet, and about 6.4 pH in those on the carbohydrate fare. Material was removed at weekly intervals from around the gingival margins of the same eight teeth in each man. The amount of debris was estimated and a quantitative bacteriological examination (both aerobic and anaerobic) made, following a modification of the technique of Kligler and Gies. Stained slides were examined for spiral forms. The general results of the six months work are summarized below.

There was a certain uniformity in the amount of material obtained from each individual, and also from those classed according to mouth conditions, the amounts of debris following the groups as to whether the men had normal mouths, medium pyorrhea, or advanced pyorrhea. A change of diet did not appreciably alter the average amount of material from each individual.

The average number of organisms per milligram, from the aerobic and anaerobic agar plates having 7.4 pH reaction, averaged about the same for all the men on all the diets, except for more irregularity in the amounts from the normal controls. But the total bacterial counts from the anaerobic acid agar plates (pH 4.8–5.0) were much lower than from the other two media. Yet, in contrasting the number per milligram from the men on the different diets, it is seen that the average amounts were greater for those on the carbohydrate fare than for those on the protein. In the men of Group I the aciduric organisms were from four to six times more numerous on the former diet than on the latter.

The streptococci far outnumbered all other bacterial species from either of the 7.4 pH media, both relatively and absolutely, while the alpha or green-producing streptococci were the predominant forms of this group, averaging 71.2 percent of all the aerobic organisms. The gamma types were 1.4 percent and the beta only 0.13 percent. The alpha streptococci were divided into several sub-groups, *S. salivarius*

(2.2 and 2.1) and *S. milis* (1.2 and 1.1) showing the highest percentages, with a smaller number of inulin and of non-lactose fermenters. The few beta forms belonged to the strains *S. equi* and *S. pyogenes*.

The principal organisms isolated from the extremely acid agar (pH 4.8–5.0) were members of the lactobacillus group, with a smaller percentage of streptococci and of slender thread forms. The aciduric rods were a heterogeneous group that could be differentiated into seven different strains by their carbohydrate reactions, the first two of which corresponded to types A and C of Rahe's classification for *Lacto. acidophilus*.

No sporulating anaerobes were isolated, although spore forming aerobes were occasionally present.

The salivary pH remained fairly constant for the individual and did not seem to vary appreciably with the diet, the average pH value for all the men on both diets being 7.2–7.4. The salivary reaction did not therefore follow that of the urine, which was noticeably lower for the men on the acid protein diet (average pH 5.7) and correspondingly higher for those on the carbohydrate fare (average pH 6.4).

Spirochetes were found occasionally on slides from all the men, with only a slight increase in percentage for the men on the protein diet. About twice as many of these organisms were found, however, from the men having pyorrhea as from those with normal mouths.

From this experimental evidence it would seem that the oral bacteria are more influenced by the local food remains than by any general systemic effect produced by dietary changes.

31. THE AMOEBAS OF THE MOUTH IN RELATION TO INCIDENCE OF PYORRHEA, CLINICAL SYMPTOMS, EXTENT OF LESIONS, AND AGE OF PATIENTS[22]

H. Corwin Hinshaw, Ph.D., and F. V. Simonton, D.D.S., California Stomatological Research Group and the Department of Zoology, University of California, Berkeley, Calif.

The incidence of infection with *Endamoeba gingivalis* in 357 individuals examined was 46.34 percent. These infections were diagnosed by means of cultures and stained smears. From these observations

[22] To be published in the next issue of the *Journal of Dental Research*.

we conclude that amoebas are never found in the strictly normal mouth. They are invariably found in typical inflammatory pyorrhea alveolaris from an early stage of the disease until the termination, and associated with the existence and extension of gingival pockets. They were always found in well-kept mouths of young persons when the gingival pockets were more than 2 mm. deep. Commonly, but not invariably, the gum margin had receded. It was noted that microscopic pus could always be demonstrated in cases of amoebic infection, even when macroscopic examination did not indicate the presence of leucocytic exudate. The gingivae are not always hypertrophied. No important conclusions could be reached regarding the existence of deposits of calculus in the incipient lesions, since the group of persons examined most carefully (students of dentistry) usually had their teeth scaled at frequent intervals. In later stages of pyorrhea, subgingival calculus, rapidly deposited, is associated with the growth of amoebas. Although slight amounts of detritus are usually present in amoebic infection, it is noteworthy that larger quantities seem to be unfavorable to the growth and reproduction of the parasites. Experiments in the culture tube seem to show that this inhibition is due to the presence of putrefactive bacteria. These observations indicate that the animal parasite may not be strictly saprozoic.

No correlation could be detected between this infection and the existence of caries or a history of it. Changes in the saliva that may take place in early caries have no appreciable effect on the growth of amoebas, which are never found in the absence of gross inflammation. There is almost invariably a chronic congestion of the gum and, in advanced active cases, a characteristic purplish venous stasis is frequently observed. Certain other and more acute inflammatory reactions are produced by agencies that are definitely antagonistic to the growth of this animal parasite.

It is important to note that persistent and intelligent efforts of the patient to secure good mouth hygiene are not successful in destroying this infection. A number of cases have been observed in which such treatment was ineffective. The saliva of the host is usually either plentiful, or of a consistency which forms a glairy film on the surface of the oral mucosa. Luetic patients receiving neosalvarsan and mercury treatments, which are lethal to *Treponema pallidum*, continued to harbor amoebas in the mouth. The incidence of infection with

this parasite, highest in persons belonging to older-age groups was found to be 26.74 percent in the youngest one-fourth of those studied, and 36.03 percent, 51.05 percent, and 71.06 percent, respectively, in the other quartile groups, arranged from youngest to oldest. This is true despite the fact that most of our subjects were less than thirty years of age.

32. A COMPARATIVE STUDY OF SOME COMMON MEDIA FOR THE CULTIVATION OF STREPTOCOCCI[23]

Frances Krasnow, M.A., Ph.D., and William J. Gies, Ph.D., F.A.C.D., Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York City

This study was undertaken to ascertain the differences in the availability of certain media for the growth of streptococci. Because optimum environment for an organism results in prolonged viability, change in viability was used as the criterion. Nine media were studied: hemolyzed blood, glucose, veal-infusion agar; hemolyzed blood, glucose, veal-infusion agar, plus glucose, beef-infusion broth, after the agar was "slanted:" Rosenow's dextrose, brain broth; Jablons' liver, peptone medium; Huntoon's hormone broth; Huntoon's hormone agar; beef liver agar; beef brain agar; Hastings' modification of North's medium.

No inhibitive effects were discernible four weeks after inoculation. Differences, apparent in six weeks, were very marked in sixteen weeks. All these media may evidently be used for ordinary purposes. But, when longevity of culture, without transplant, is desired, Jablons' broth is the most efficient, for it supports the life of the greatest number of organisms for the longest period.

VI. FIFTH (CONCLUDING) SESSION: AFTERNOON, MARCH 28

33. MATRIX FORMING ORAL MICROÖRGANISMS OF THE DOG[24]

Theodore B. Beust, M.D., D.D.S., School of Dentistry, University of Louisville, Louisville, Ky.

The term "matrix" was formerly applied to clumps of microörganismal matter found in smears taken from the *materia alba*, or tooth felt.

[23] To be published in an early issue of the *Journal of Dental Research*.

[24] Work supported in part by a grant from the Research Commission of the American Dental Association.

In a paper read before the Seventh International Dental Congress, the author pictured several forms of matrices found in the human mouth. This contribution deals with a new form in the mouth of the dog. Specimens exhibiting flexible thread-like conidia of nearly 150 micra in length were found. The spore-like bodies surrounding the central stem were of fusiform shape. In addition to these matrix-forming organisms, threads of the Leptothrix gigantea of the dog were shown, some of which were devoid of protoplasm, a condition suggesting the occurrence of zoospore or gamete formation.

The successful preparation of specimens of the matrix-forming organism depends largely on the methods utilized in collecting and staining. Scrapings removed from the teeth with a sharp blade, and separated on a cover-glass in a drop of water with the aid of two pins, promise the best results. Allow to dry spontaneously—do not heat. Iron-haematoxylin stain, preceded by a fixation of some kind, is good. Staining with fuchsin is, perhaps, the simplest. Float the cover-glass face down, in freshly prepared Ziehl's fuchsin, warmed to the steaming point, for at least five minutes. Wash in water; differentiate by washing in concentrated aqueous solution of carbolic acid for a few seconds; wash in water; dip in 20 percent alcohol for a few seconds; wash in water; dry; Canada balsam. This method produces slides of exceptional brilliance.

34. REPORT ON A COURSE IN DENTAL TECHNOLOGY, USING A MASTER CHART BASED ON THE RECTILINEAR COÖRDINATE SYSTEM[25]

W. E. Cummer, D.D.S., F.A.C.D., Dental School, University of Toronto, Toronto, Canada

That the profession of engineering is closely related to dentistry again becomes apparent when, after a survey, it is found that at least 172 different technical procedures used in dentistry are drawn from the vast store of the technology of the different crafts in engineering. The author presented a master chart constructed with these operations as the ordinate, and thirty projects or pieces of work in a course in dental technology (5 lecture, 75 laboratory, hours), now in operation at the College of Dentistry, University of Toronto, as the abscissa. Instead

[25] To be published in an early issue of the *Journal of Dental Research*.

of the usual curve are the figures showing the sequence and frequency with which these technical procedures are done by the student during the course, with totals of each at the side of the chart. Illustrations of each of the projects, with drawings or printed descriptions accompanying them, and of the plan for providing the supplies and requirements for the student, were presented. The lectures were outlined, and views of the laboratory for dental technology at the University of Toronto were shown.

35. PHYSICAL PROPERTIES OF DENTAL MATERIALS

Louis J. Weinstein, Sc.D., Dental School, New York University, New York City, and R. L. Coleman, B.S., National Bureau of Standards, Washington D. C.

The authors summarized the results of a six-year program of research on the physical properties of dental gold alloys, wrought and cast, investments, waxes, and model compounds, carried on jointly by the National Bureau of Standards and the Weinstein Research Laboratories. The data covered in this paper were taken mainly from progress reports[26] of the research published with the approval of the Director of the Bureau. The outstanding results reported in this paper were these:

(a) Engineering methods for testing industrial materials of construction were modified and adapted to dental materials, and, where necessary, new methods were developed. The properties of a large number of representative dental materials were accurately determined.

(b) From the knowledge of the properties of the materials thus obtained a number of improvements in the methods of manipulation, especially in the dental casting processes, were developed.

(c) Through these methods of testing, the dental profession and

[26] Dental Research: *Journal of the American Dental Association*, xi, pp. 249–250, March, 1924. Wrought gold alloys: *Journal of the American Dental Association*, xii, pp. 509–546, May, 1925. The dental casting process: *Dental Cosmos*, lxviii, pp. 743–764, August, 1926. Analysis of dental gold alloys: Scientific paper of the Bureau of Standards, No. 532; *Journal of Dental Research*, vii, pp. 373–410, December, 1927. The selection of dental materials: *Journal of the American Dental Association*, xiv, pp. 189–199, February, 1927. Cast gold alloys: *Dental Cosmos*, lxix, pp. 1007–1026, October, 1927. Tentative government specification for gold alloys: *Journal of the American Dental Association*, xv, April, 1928.

schools have been provided with a means of grading materials and selecting those most suitable for specific purposes.

(d) The results of this research furnish a basis upon which definite specifications for these materials may be established. Such specifications for gold alloys have already been set up and are being used by the Government Departments.

36. PRELIMINARY REPORT OF A GNATHOPHOTOSTATIC INVESTIGATION OF THE HUMAN DENTURE AND SEVERAL DENTOFACIAL RELATIONS

B. E. Lischer, D.M.D., F.A.C.D., St. Louis, Mo.

The customary, orthodontic, plaster casts of the teeth do not show possible jaw deformities. The usual orthodontic facial photographs fail to reveal the dental anomalies that stand in causal relation to the facial deformities. And these two kinds of data from orthodontic case-records are seldom adequately related and confirmative. The popular phrase, "malocclusion of the teeth," does not adequately express the relative extent of dentofacial anomalies, and the relation of the denture to the head and face is universally conceded to be a basic consideration in orthodontic diagnoses. These reflections, and the difficulties continually encountered in the differential diagnosis of dentofacial deformities (which may involve not only the occlusion of the teeth, but the dental arches, alveolar processes and supporting jaws, plus several of the facial features), have finally led to a general questioning of the philosophy of empiric and idealistic diagnostic classifications, and of exclusively intraoral methods of diagnosis.

Simon maintains that, to be acceptable, a classification of dental anomalies must be (a) logical and comprehensive; (b) based on morphological principles, so that the form relations of a denture, and its relations to the head, can be determined; (c) obtainable by methods that are reasonably accurate and scientific, and based on objective data, not subjective opinions; (d) must survey the denture in three dimensions, namely, length, breadth and height; (e) must include the data of variation, as well as modification and deformity; and (f) must contain possibilities and methods for calculating the mean, or average, of each characteristic. Finally, "the *normal* type is gained by calculating the mean, or average, from the table of individual values,"

obtained from anatomically correct dentures in the living. All previous methods of diagnosis failed to meet these requirements in one or more particulars, hence Simon devised "gnathostatics" and a new classification of dentofacial deformities, based on essential biometric and cephalometric principles. He also simplified its technique, to meet the demands of practice as well as of science.

FIG. 11. Gnathostatic dental cast of an anatomically correct denture

The diagnosis of malocclusion of the teeth and dentofacial deformities may be defined as the determination of the differences between the existing denture of a patient and the condition to be established. This is a morphologic problem, because an anomaly is not a disease, but a deviation of form. And the condition to be established is based upon the norm-concept, a useful fiction applied biometrically in this instance, but more trustworthy than the fictions heretofore employed. The orthodontic diagnostic norm is a constructional aid, the product of

our thinking and striving, because we can never find a norm in nature or objective reality. This norm is constructed in compliance with the three dimensions of length, breadth, and height, and is the mean derived from the table of individual values mentioned above. Three arbitrary, or imaginary, planes are utilized, because there are no natural planes in the head of any patient. The planes employed by Simon are the well-known horizontal (eye-ear) and median (raphe) planes, and his frontal (orbital) plane. The raphe median and orbital

FIG. 12. *A*.—Photostatic photograph of the profile of the individual whose dental casts are shown in *fig. 11*. *B*.—Lines drawn connecting the cephalometric points shown in *A*.

planes intersect the denture and, with the aid of the gnathostat, the horizontal plane serves as a base for the maxillary plaster cast (*fig. 11*). By adopting the principle of rectangularity, gnathostatics standardizes and simplifies the application of these planes, so that we can determine the relations of the denture to the three planes, and to the head.

This comprehensive accomplishment was further effected by adequately relating "photostatic" photographs of the patient's profile to his gnathostatic denture casts (*fig. 12, A*). Such photographs are executed in a very definite manner, and show the ***orbitale*** and ***tragion***,

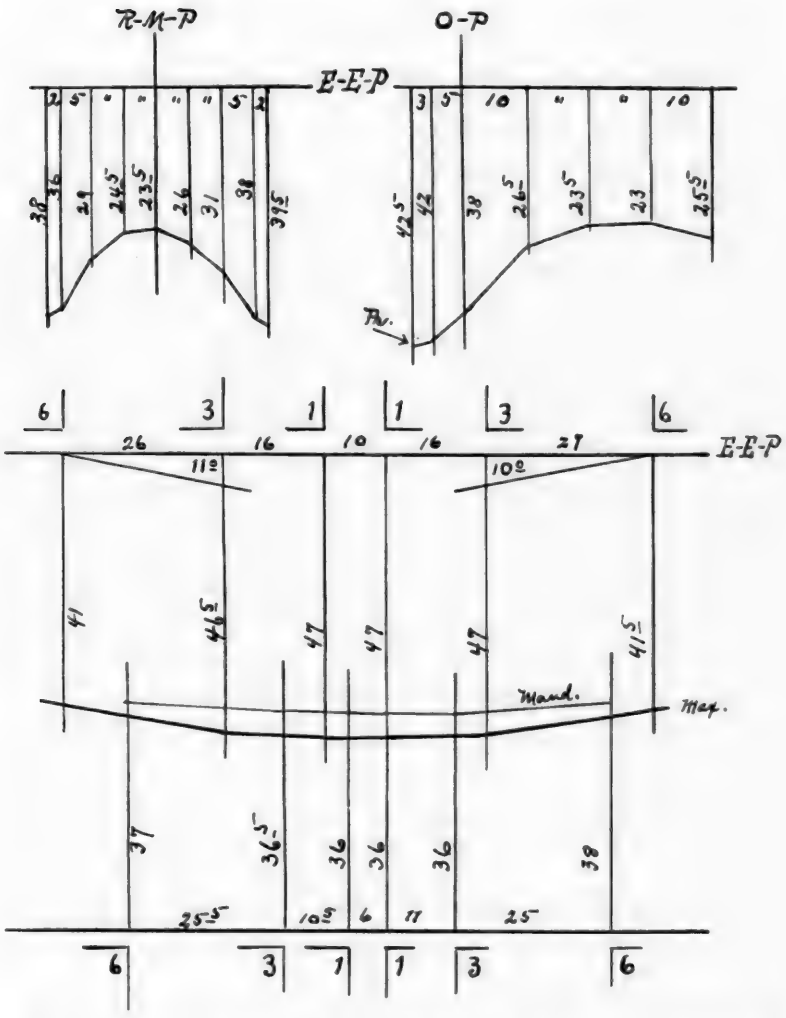


FIG. 13. Data showing method of obtaining graphs of the transverse, sagittal, and occlusal curves of each case. The mean of the series will provide norms for diagnostic use.

points employed for orienting the gnathostat; also the *gonion*, a point at the angle of the mandible. By drawing the lines shown in *fig. 12, B*, we indicate the position of the horizontal and frontal planes on the head, and the behavior of the mandible and principal facial features to the coördinate system.

The definite and accurate technical methods employed[27] in constructing the casts shown in *fig. 11* enable us to procure graphs of the transverse, sagittal, and occlusal curves of each case, and to demonstrate their relations to the planes (*fig. 13*). The actual measurements of the abscissae and ordinates are shown. It is obvious that, owing to variation, these measurements vary between different individuals, and between lateral halves of the same individual. "Symmetry is biological, not mathematical."

The writer is engaged in a gnathophotostatic investigation of a large group of individuals possessing anatomically correct dentures, to determine their cephalometric relations and the behavior of the facial lines to the coördinate system.

37. THE DISTRIBUTION IN SITU OF ENDAMOEBA GINGIVALIS, AND ITS RELATION TO THE FILAMENTOUS BACTERIA IN CALCULUS[28]

C. A. Kofoid, Ph.D., Sc.D., and H. C. Hinshaw, Ph.D., California Stomatological Research Group, and the Department of Zoology, University of California, Berkeley, Calif.

Illustrations giving the precise distribution of *Endamoeba gingivalis*, normally *in situ* in the pyorrheal pocket, are lacking in dental literature. Two right mandibular incisor teeth, removed at biopsy from a typical case of pyorrhea of the sulcicalcic type, were decalcified and sectioned with teeth, calculus, interdental papilla, and adjacent tissues intact. In a frontal section the subgingival calculus forms two symmetrical subtriangular masses enlarging as they extend downward and widest near their lowest level, where they reduce the interdental papilla to one-fourth its normal thickness. The calculus is deposited throughout a radiating growth of *Leptotrichia buccalis*, the filaments

[27] For a complete description of these methods the reader is referred to Simon's Diagnosis of dental anomalies; Stratford Press, Boston, 1926.

[28] To be published in an early issue of the *Journal of Dental Research*.

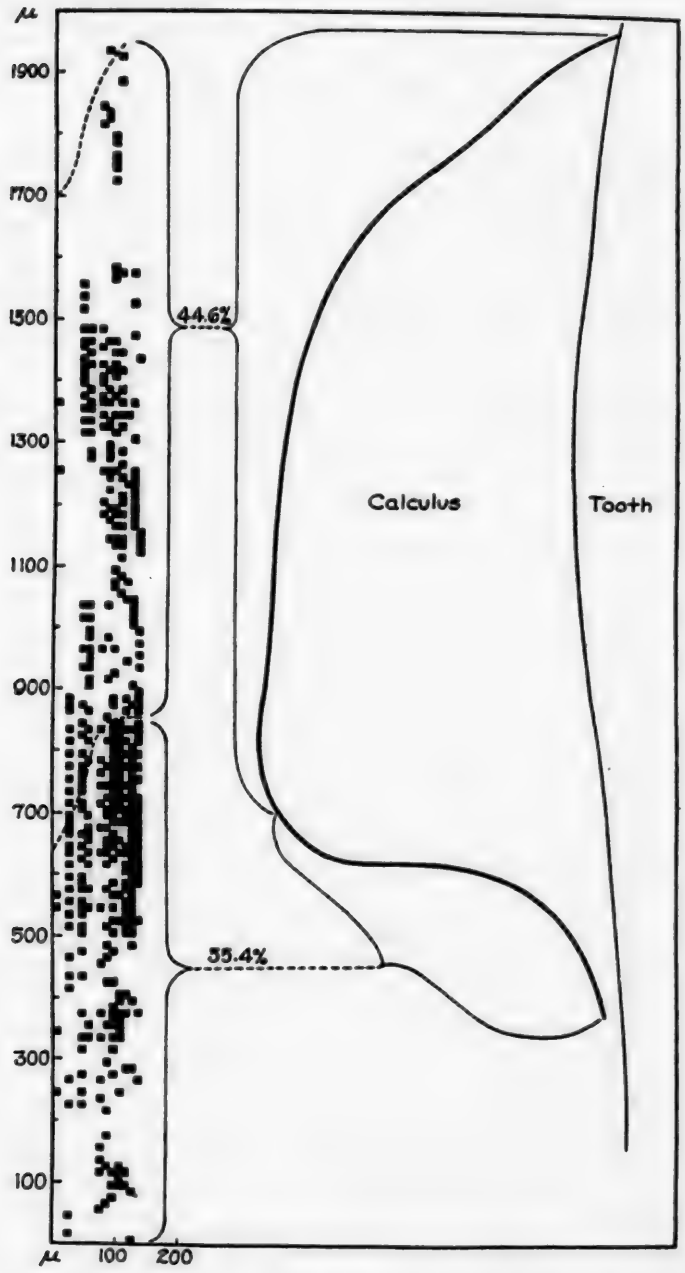


FIG. 14. Diagram showing distribution of *Endamoeba gingivalis* on the surface of subgingival calculus. Each square represents one amoeba drawn to scale of minimum size (12.7μ in diameter). Three sections of the series are missing. To the right is a diagrammatic section of the calculus in outline. Note the localization of amoebae at the points of greatest width of the section of calculus. Of the amoebae 42 percent are localized, in approximately 20 per cent of the area studied, nearest to the greatest amount of calculus.

of which protrude beyond it as a thick-set carpet-like pile of branching bacterial growth. This growth abuts directly upon the constricted interdental papilla, from which large numbers of leucocytes, largely polymorphonuclears, gather throughout the fringe of the bacillary growth and constitute the escaping pus. Their denuded nuclei make up the contents of the food vacuoles of the numerous adjacent amoebae. The free fringe of uncalcified filaments of *Leptotrichia* is crowded with motile *Endamoeba gingivalis*. No amoebae are to be found burrowing into the adjacent interdental papilla, and are most abundant where the calculus is widest, namely, at the protecting edge of its deeper end. The calculus in section forms approximately a right-angled triangle. The distribution of the amoebae in the bacillary fringe on the surface of this triangular section of the tartar is as follows: 44.6 percent are on the ascending hypotenuse, and 55.4 percent are below the ledge formed at the widest and deepest part. Of the latter, 42.2 percent are above the midpoint and only 13.2 percent are below the midpoint. They diminish rapidly in number on the calculus toward the crown and toward the bottom of the pocket, as determined by count. See the accompanying diagram of distribution (*fig. 14*).

Under this area of thickest deposit there is a narrow extension of the calculus on the surface of the tooth below the main mass. A number of amoebae have passed into the subgingival groove beyond the level of the main mass of the calculus and its slender extension. The distribution and numbers of the amoebae are directly correlated with the area and volume of the calculus, except for their preponderance in the area of deeper extension. The degree of inflammation, as shown by the numbers and distribution of leucocytes adjacent to the calculus, bears a general relation to the mass of calculus, *Leptotrichia*, and amoebae. The infiltration of the papilla adjacent to the masses of calculus is noteworthy.

The grouping of the invading organisms, with reference to the calculus and to the area of inflammation, is indicative of a biological association or complex of interdependent organisms and their accompanying reactions. The *Leptotrichia* is directly concerned with the deposition of the calcium salts, a process with which other related bacteria in mineral springs are widely associated in nature. The

amoebae find, in the pile of projecting filaments, conditions favorable for shelter and food supply, and a pH conducive of growth and multiplication. The inflammation process in the adjacent interdental papilla results in the accumulation of degenerating leucocytes in the subgingival groove, in masses crowded against the calculus. The amoebae ingest the denuded nuclei of these cells and eject from their food vacuoles their liquefied contents. The chromatin-rich nuclei contain nucleoproteins having large proportions of phosphorus, which in later changes may contribute to the phosphate of calcium in the forming calculus. The increase in volume of the calculus, with its associated organisms, is correlated with the increasing inflammation and with the increasing extension of the lesion.

38. MEDICO-DENTAL CASE RECORDS: VI. CANCRUM ORIS[39]

Bissell B. Palmer, Jr., D.D.S. and Malcolm W. Carr, D.D.S., New York City

This report presented a case history of cancrum oris (noma) in an adult, with fatal termination. The incidence of noma in adults is not common. The history of this case narrates several unusual phases of the disease regarding etiology, point of origin, course, treatment, and termination. The disease process originated from a small ulcer located on the buccal surface of the muco-periosteum adjacent to the right mandibular bicuspids. It was complicated by Vincent's infection, and extended rapidly through the tissues of the cheek, resulting in wide-spread destruction of the face from the angle to the symphysis of the mandible. It also involved the lower and upper lips to the median line, the ala of the nose, and extended superiorily to the infra-orbital structures and zygomatic process. In the last stages of the disease the patient became totally blind in the right eye, and showed severe signs of secondary anemia with marked cachexia. The primary fatal lesion was the extensive cancrum oris, and the secondary or terminal lesion, causing death, was edema of the glottis.

[39] To be published in an early issue of the *Journal of Dental Research*.

39. SALIVARY MUCIN AND SOME OF ITS ORAL RELATIONSHIPS[30]

James M. Inouye, Ph.D., and Edgar G. Miller, Jr., Ph.D., Laboratory of Biological Chemistry, College of Physicians and Surgeons, Columbia University, New York City

The nephelometric method[31] was used to determine the mucinate content of saliva. The subjects were "average" adult males, selected with no reference to dental condition. Saliva "stimulated" by chewing paraffin (52 samples, 18 subjects) gave an average mucinate content of 0.27 percent (calculated as Na mucinate), with a "probable error," for the series, of 0.06. Only five samples were below 0.15 percent and two above 0.41. The range was between 0.08 and 0.60 percent; the widest in one individual was 0.08 to 0.37 percent. In general, the variation in the same persons on different days was as great as between individuals. Twenty-one samples, collected from eight subjects without any mechanical or chemical stimulation, gave an average value of 0.25 percent, with a "probable error" of 0.06—essentially the same result as that following paraffin chewing.

Accumulation of samples under lime-juice stimulation, 20 minutes after a paraffin-stimulated collection, gave a decrease in mucinate content in each of six cases (the decrease amounting in four cases to as much as 0.10 percent). This accords with the frequent observation of a "watery" saliva after acid stimulation, perhaps due to increased parotid activity. In a short series (3 cases) cigarette smoking induced no consistent change in mucinate content. In seven tests, in which small amounts of sugar ("rock candy") were used after controls, there was a consistent decrease in the mucinate content. The maximum fall was not determined, in four cases the dilution having made the nephelometric comparison unreliable. As this result followed stimulation by small amounts of sugar, it does not contradict the common observation of an increase in the mucigenous quality of saliva through the local action of large amounts of sugar.

As a partial check on the results, the total nitrogen content of cleared and dialyzed saliva was determined in many cases. The

[30] A portion of this work was published in the *Proceedings of the Society for Experimental Biology and Medicine*, 1927, xxv, p. 153.

[31] Inouye: Studies of salivary mucin and its quantitative determination. Dissertation, Columbia University; 1924.

values obtained showed the same trend and magnitude of change under different stimulations, and corroborated the values for mucin content, assuming that the protein present was largely mucinate.

The reactions of salivary mucin, prepared from ox submaxillary glands, have been further studied. We had previously reported that, contrary to the usual statements, mucin, in biological concentrations as a solution of sodium mucinate, is not precipitated by salts of lead or mercury. We have added serum protein, prepared from dog and ox bloods, to mucinate solutions; treated the mixtures with lead salts; filtered; and found in the filtrates, with the serum proteins quantitatively removed, a content of nitrogen exactly corresponding with that of the original mucin. Mercury salts did not prove to be as satisfactory for the separation.

40. CANADIAN NATURAL RESOURCES AND DENTAL MATERIALS[22]

Thomas Cowling, M.A., L.D.S., D.D.S., Faculty of Dentistry, University of Toronto, Toronto, Canada

The recent world war disclosed the dependence of the Canadian dental profession upon imported materials. During this period Canadian manufacturers of dental supplies faced a situation where it was impossible to meet the needs of the profession. Many of the most essential items of supply were completely cut off and no satisfactory substitutes were forthcoming. Because of this the manufacturers, the dentists, and the public alike paid dearly for the adherence to a traditional policy of dependence upon importations. That this situation was avoidable may be demonstrated by even a superficial examination of Canada's mineral resources, such as has been made in this report. It is not urged that all materials used by Canadian dentists should be manufactured in Canada; that is economically impracticable. Rather, the purpose is to direct attention to the potential richness of Canada's mineral resources, and to bespeak a more extensive use of them.

The report deals specifically with such dental materials as the metals, abrasives, porcelains, cements, refractories, and investment, modeling

[22] Work done in the Departments of Geology and Mineralogy, McMaster University, Toronto, Canada. To be published in an early issue of the *Journal of Dental Research*.

and impression materials, etc. The mineral sources of supply of these materials in the several provinces of the Dominion are cited, together with a description of the geological conditions accompanying them. Special attention is given to the specific geological formations that appear promising as possible sources of the dental materials that are not at present obtainable in commercial quantities, yet are of outstanding importance in dental technology. It is shown that Canada possesses a veritable storehouse of minerals that are particularly suited for supplying the needs of the dental profession. In many instances the native supplies are far superior in quality as compared with the imported materials. A serious economic loss is also sustained when raw materials are sent out of the country to be subsequently reimported as refined products in the form of dental supplies. Such a practice imposes a considerable financial burden upon the Canadian dental profession, and ultimately increases the cost of dental service. It is probably true that a more extensive use of the natural resources would make possible an enlarged field of operation for the Canadian dental health service.

41. FACTORS IN THE FORMATION OF SALIVARY CALCULUS

Sam Karlström, D.M.D., and Edgar G. Miller, Jr., Ph.D., Laboratory of Biological Chemistry, Columbia University, College of Physicians and Surgeons, New York City

The formation of dental tartar has been explained on various theories, including as factors the gain or loss of CO_2 and the effect of the protein of the saliva. We should expect that the presence of colloidal proteins would to a certain extent, due to "protective colloid action," salt formation, etc., stabilize the saliva against precipitation of Ca salts by CO_2 exchange. These preliminary experiments were done to test the extent to which such influences might be active. The CO_2 used was generated from $CaCO_3$ and washed; the speed of addition of the gas to the test material was kept as constant as possible. Aeration was with washed air. The gelatin used was commercial "sheet." The serum, obtained from ox blood, was cleared of euglobulin by dilution with four volumes of water, treatment with CO_2, and filtration. The egg albumin was Merck's "impalpable powder."

The mucoid was prepared from ox tendon. The sodium mucinate was from ox submaxillary glands, and purified. Ca determinations were done by the McCrudden method.

To 50 cc. portions of saturated $Ca(OH)_2$ solution were added Na_2HPO_4 (2 cc. of a 5 percent solution), NH_4OH (in amounts from 1 cc. of a 2 percent solution to 2 cc. of a 5 percent solution), and $NaHCO_3$ (2 to 5 cc. of a 5 percent solution), singly and in various combinations. All were made up to a volume of 100 cc. with distilled water, then treated with CO_2, and the time required for maximum precipitation and subsequent maximum clearing noted in each case. The tests were then repeated, with additions of gelatin (2 to 10 cc. of 10 percent solution), or serum (5 to 15 cc. of the 20 percent diln.). The time required for maximum development of turbidity was approximately the same in the presence of protein as in its absence (varying from 20 to 45 sec.). This is true also for the time required for re-solution of the precipitate (varying from 1.5 to 6.5 min.), but there was an evident reduction in the amount of precipitation in the presence of protein.

A solution of $Ca(OH)_2$ was treated with CO_2 to complete re-solution of the initially precipitated carbonate. To 100 cc. of this bicarbonate solution (containing 33 mgm. Ca) were added 50 cc. of water; to another 100 cc. portion, 50 cc. of 0.5 percent solution of egg albumin. They were then aerated for 1.5 hour and filtered. In the presence of the protein, 78 percent of the Ca remained in the filtrate; in the control, 37 percent. A suspension of $Ca_3(PO_4)_2$ in water was treated for four hours with CO_2, and filtered. To 150 cc. of this filtrate (containing 11 mgm. Ca as acid phosphate and bicarbonate) 50 cc. of water were added; to the other, 50 cc. of 0.5 percent egg albumin. Both were aerated for 1.5 hour and then filtered. In the presence of the protein, 100 percent of the Ca remained in the filtrate; in the control, 69 percent.

To one of two 100 cc. samples of $Ca(OH)_2$ solution (48 mgm. Ca) was added tendomucoid to a proportion of 0.05 percent. Both were then treated with CO_2 to approximate maximum turbidity, and filtered. In the presence of the protein, 86 percent of the Ca remained in the filtrate; in the control, 35 percent. Tendomucoid was added, in a proportion equal to 0.05 percent, to one of two 100 cc. samples of $Ca(OH)_2$ solution (48 mgm. Ca). Both were treated with CO_2 to

re-solution of the original precipitate, then aerated 1.25 hour, and filtered. In the presence of the protein, 97 percent of the Ca was in the filtrate; in the control, 23 percent.

One of two 100 cc. samples of $Ca(OH)_2$ solution (44 mgm. Ca) received an addition of sodium mucinate (0.05 percent). Both volumes were then treated with CO_2 to approximate maximum turbidity, and filtered. In the presence of the protein 57 percent of the Ca was in the filtrate; in the control, 36 percent. The experiment was repeated, except that the CO_2 treatment was continued to re-solution of the precipitate, and both samples were then aerated for 1.25 hour and filtered. In the presence of the protein, 41 percent of the Ca was in the filtrate; in the control, 23 percent.

It was noted throughout that the Ca precipitate settled out, in the absence of protein, in less than 1.5 hour, while when protein was present there was practically no sedimentation at the end of 24 hours.

It is evident that gain or loss of CO_2 by the saliva may be a factor in the deposition of dental tartar. The protein colloids in the saliva markedly reduce the precipitating and depository influences of changes in CO_2 content in its relation to Ca precipitation.

42. COMPOSITION OF SOME SALIVARY CALCULI

Maxwell Karshan, M.A., Ph.D., and Joseph Schroff, B.S., M.D., D.D.S.,
Biochemical Laboratory and Department of Oral Pathology,
Dental School, Columbia University, New York City

In an analysis of human salivary calculi from various sources, calcium, phosphorus, and magnesium were determined by the method of Howland, Marriott, and Kramer;[33] CO_2, from carbonate, by the method of Shear and Kramer,[34] in the Van Slyke and Neill manometric gas-analysis apparatus. The distinctive feature of these methods is the elimination of ashing, which, when organic matter is present, as pointed out by Wells,[35] converts organic phosphorus into phosphate and carbon into carbonate, thus yielding erroneous figures for Ca, Mg, P, and CO_2, if expressed as calcium phosphate, magnesium phosphate, and calcium carbonate—compounds presumably

[33] Howland, Marriot and Kramer: *Journal of Biological Chemistry*, 1926, lxviii, p. 711.
[34] Shear and Kramer. Private communication.
[35] Wells: Harvey Lectures, 1910–11.

present in salivary calculi. The content of organic matter was determined by ashing, and subtracting the weight of the ash from the total. The material was extracted with a mixture of alcohol and ether in a Soxhlet apparatus for the separation of lipins. All calculations were made on a dry basis, the material having been heated to 100°C. to constant weight before analysis. The results are summarized in *Table 1.*

TABLE 1

*Analysis of salivary calculi**

	SOURCE				
	Left submaxillary gland: single calculus	Five small calculi from same source as I	Six small calculi from duct of right submaxillary gland	Duct of right submaxillary gland: single calculus	Right submaxillary gland: single calculus
	I	II	III	IV	V
Weight in grams	2.92	1.01	0.63	5.71	1.44
CO_2 (%)	1.99	1.68	1.38	2.39	2.09
Ca (%)	29.2	30.4	32.8	32.4	33.9
P (%)	14.1	14.6	13.7	16.2	15.9
Mg (%)	0.59	0.58	0.43	0.33	0.34
$Ca_3(PO_4)_2$ (calc. %)	68.0	70.5	66.7	79.6	78.1
$Mg_3(PO_4)_2$ (calc. %)	2.00	1.97	1.46	1.12	1.16
$CaCO_3$ (calc. %)	4.52	3.82	3.14	5.43	4.75
Organic matter (%)	22.5	22.7	28.4	13.5	12.9

* Lipins (alcohol-ether soluble material): absent from all samples.

After subtracting enough Ca from the total Ca to make $CaCO_3$, and after taking sufficient P from the total P to make $Mg_3(PO_4)_2$, the ratio of residual Ca to residual P is successively 2.01, 2.05, 2.31, 1.90 and 2.05 for samples I, II, III, IV, V, respectively. In $Ca_3(PO_4)_2$ the ratio of Ca to P is 1.94. The closeness of the above ratios to the theoretical 1.94 justifies the conclusion that the calcium phosphate in salivary calculi exists as $Ca_3(PO_4)_2$.

43. THE ERUPTION AND GROWTH OF THE PERMANENT TEETH[36]

Psyche Cattell, M.A., Ed.M., Ed.D., School of Education, Harvard University, Cambridge, Mass.

In connection with an extensive study of the growth of school children, conducted at Harvard University under the direction of Professor Walter F. Dearborn, over 7000 dental examinations have been made on children of North European descent. The teeth were recorded in three stages of growth: (a) from the time the tooth first erupted the gum until it had reached one third its adult size; (b) from one third to two thirds adult size; and (c) from one third adult size to full occlusion. A table was constructed giving the age at which 25 percent, 50 percent, and 75 percent of boys, and of girls, had erupted each pair of teeth, together with percentile charts showing the percentage of boys and girls at each age who had each pair of teeth erupted. The teeth were treated in pairs, since no consistent difference was found in the time of eruption of a tooth on the right side of the jaw and its mate on the left.

The rate of growth of teeth, after they have broken the gum, was estimated by calculating the difference in the age at which 50 percent of the cases had the tooth in question recorded as erupting or further advanced, and the age at which 50 percent had it recorded as in full occlusion. This procedure gave from eight to nine months as the time required for an incisor tooth to obtain its full growth after having broken through the gums, and about four months for the premolars. Owing to the fact that a tooth may remain in the stage "erupting" for two months or more, it is probable that the time taken for growth is longer than the figures indicate. These estimates are admittedly rough, but there appears to be no available information that is more reliable. A study based on examinations repeated on the same individuals at short intervals is now in progress. Thus far the results confirm the conclusions given above.

[36] Published in the *Journal of Dental Research*, 1928, viii, p. 279 (April).

44. A STUDY OF CERTAIN DENTAL CHARACTERS IN SEVERAL RACES OF MANKIND[37]

Milo Hellman, D.D.S., F.A.C.D., Department of Comparative Dental Morphology, College of Dentistry, New York University, and Department of Physical Anthropology, American Museum of Natural History, New York City

The author pointed out certain resemblances and differences in the tooth patterns of several racial groups. The study comprised Living Americans, European Whites, Ancient European Whites, Asiatic Mongols, Hindus, African and American Negroes, American Indians, and a group of Eskimos. The patterns of the lower molar teeth are taken as examples. Even with the widest range of variation, these patterns may be traced through intermediate stages to a fundamental type, named by Gregory the "*Dryopithecus* pattern." It is found on all lower molars of the anthropoid apes and extinct early Man. Certain changes are becoming apparent which tend to modify the primitive *Dryopithecus* pattern in both man and apes. The changes in the ape molars appear in the form of specific adaptations but the fundamental pattern is retained. In man, the changes tend to modify the fundamental pattern by a gradual and progressive process of evolution. There are four stages of progressive modification in the lower molar teeth of man, which are defined by changes in the number of cusps and modification in the system of grooves. The teeth of all races of man show the various stages of progress. The most advanced stage, however, is attained by the largest number among Whites and by the smallest number among Negroes, the Mongols occupying an intermediate position.

Comparisons of males and females of the same groups show that the female molars are conservative in some respects and in others progressive. Comparisons of Ancient and Modern Whites show the latter more advanced. Comparisons of West African and American Negroes show the changes similar in kind but different in degree, the American Negroes being more progressive.

[37] Also presented at the annual meeting of the American Philosophical Society, in Philadelphia, April 20, 1928.

45. THE AVAILABILITY OF INORGANIC SUBSTANCES FOR STREPTOCOCCI[38]

Frances Krasnow, M.A., Ph.D., and Miriam Reiner, B.A., Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York City

A surprisingly large number of the eighty media tested were capable of sustaining the organism for longer or shorter periods, and at higher or lower planes of metabolism. Inorganic nitrogenous compounds were not included. Thirty-three percent of the media, containing only inorganic substances, supported life to some extent; 11 percent were comparatively good, 10 percent fair, 12 percent poor. All containing *sulphur* supported growth; nine, or 82 percent of them, gave good growth, while two, or 18 percent, were poor in this respect. The addition of sodium thiosulphate was beneficial in about 44 percent of the media tested. Sulphur is exceptionally beneficial to streptococcus metabolism in media containing only inorganic substances. *Calcium* is always beneficial to some extent. *Sodium* and *potassium* seem to be interchangeable. There was a definite increase in vitality upon addition of *ferrous* sulphate in some cases, but a decrease in others.

46. A STUDY OF THE INFLUENCE OF POTASSIUM CHLORATE ON NUTRITION[39]

Maxwell Karshan, M.A., Ph.D., and William J. Gies, Ph.D., F.A.C.D., Laboratory of Biological Chemistry, Schools of Medicine and Dentistry, Columbia University, New York City

Growing albino rats, in comparable sub-groups of six or seven each, under nutritive conditions favorable for the detection of general effects, were given comparatively large amounts of potassium chlorate daily with the diet (usually mixed with meat), without inducing special toxic symptoms. The doses, in four experiments on different groups, ranged from 0.002 to 0.7 gram per rat per day, during periods of 56 to 78 days and included the largest proportions of chlorate that might be

[38] To be published in an early issue of the *Journal of Dental Research.*
[39] To be published in an early issue of the *Journal of Dental Research.*

ingested in the use of a dentifrice. Compared with control rats given equivalent molecular amounts of sodium chloride or potassium chloride, those that received potassium chlorate did not grow quite so rapidly, weighing, at the ends of three experiments, from 16 to 29 grams *less* per rat. In one experiment, however, in which the average *initial* weight of the tested rats was 7 grams greater than that of the controls, the terminal average weight was 5 grams higher than that of the control animals (*Table 2*). The significance of the observed effect on growth and weight has not yet been determined.

The complete paper will include additional facts on this aspect of the

TABLE 2

Data pertaining to the influence of potassium chlorate

EXPERIMENT	SEX OF RATS	PERIOD DURING WHICH $KClO_3$ WAS GIVEN	AVERAGE INITIAL WEIGHT OF RATS		AVERAGE TERMINAL WEIGHT OF RATS		DAILY DOSE OF $KClO_3$
			Control	Tested	Control	Tested	
		days	*grams*	*grams*	*grams*	*grams*	*grams*
I	Male	56	79	86	202	207	0.002–0.7
II	Female	78	72	72	168	152	0.07– 0.5
III	Male	65	54	54	212	184	0.1– 0.4
IV	Female	59	54	54	146	117	0.1– 0.4

subject, and also data on the influence of potassium chlorate on pregnancy, on pre-natal growth, and on development during lactation.

47. THE FREQUENCY OF THE OCCURRENCE OF CERTAIN STRUCTURAL VARIATIONS IN HUMAN ENAMEL, DENTINE, AND CEMENTUM[40]

Lawrence E. Van Kirk, A.B., D.D.S., School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

In this investigation, the frequency of occurrence of the following conditions was determined: (a) enamel spindles; (b) granular rods; (c) secondary calcification in the pulp chamber; (d) various arrangements of enamel, cementum, and dentine at the gingival line.

The material examined consisted of ground sections of human teeth from the collection in the Histology Department of the University of

[40] To be published in an early issue of the *Journal of the American Dental Association.*

Pittsburgh Dental School. The results are shown in *Table 3*, where, unless otherwise specified, the numerals indicate actual numbers examined or observed. The data justify the following conclusions:

TABLE 3

Data relating to structural variations in enamel, dentine, and cementum

TEETH	SPINDLES		GRANULAR RODS		SECONDARY DENTINE			CONDITION OF ENAMEL, CEMENTUM, AND DENTINE AT THE GINGIVAL LINE*					
	Present	Absent	Present	Absent	Present	Absent	Undetermined	Junctions examined	Cementum overlaps enamel	Cementum meets enamel	Enamel overlaps cementum	Dentine exposed	Undetermined
Superior central incisors	24	26	50	0	40	7	3	100	30	10	1	14	45
Superior lateral incisors	34	16	50	0	32	7	11	100	19	27	2	6	46
Superior cuspids	35	15	50	0	36	2	12	100	36	13	0	7	44
Superior bicuspids	50	0	50	0	19	23	8	50	25	6	0	0	9
Superior molars	49	1	50	0	16	30	4	51	31	6	0	1	13
Inferior incisors	38	12	50	0	32	6	12	82	18	12	1	10	41
Inferior cuspids	39	11	50	0	31	15	4	82	40	5	2	1	34
Inferior bicuspids	49	1	49	1	26	19	5	100	43	8	1	1	47
Inferior molars	50	0	50	0	27	23	0	100	55	12	0	0	33
Totals:													
All teeth	368	82	449	1	259	132	59	765	297 (67%)*	99 (22.4%)*	7 (1.58%)*	40 (9%)*	322*

* The percentage data at the bottom of the second, third, fourth, and fifth columns indicate the respective proportions in the total number of junctions where the tissue relationships could be accurately determined (443). For 322, these relationships could not be established, usually because of unavoidable damage in grinding.

a. Enamel spindles are quite generally distributed in bicuspids and molars. In the anterior teeth, they are concentrated around the cusp tip.

b. Granular rods are found in practically all ground sections.

c. Secondary deposits were more numerous in pulp chambers of anterior teeth than in the bicuspids and molars.

d. At the gingival line, the cementum overlapped the enamel in 67 percent of the teeth examined. The cementum and enamel met in 22 percent. The enamel overlapped the cementum in 1.5 percent. The enamel and cementum failed to meet, leaving the dentine exposed, in 9 percent.

VII. List of the Officers, and New Members, Elected March 26–28[41]

OFFICERS (1928–29)

President—Leroy M. S. Miner, Harvard University; *President-elect*—Arthur D. Black, Northwestern University; *Vice-President*—F. V. Simonton, University of California; *Treasurer*—William Rice, Tufts College; *Secretary*—William J. Gies, Columbia University.

NEW MEMBERS[41]

Ann Arbor, Michigan

Faith Palmerlee Hadley, College of Dentistry, University of Michigan, Ann Arbor, Mich.

Baltimore, Maryland

E. V. McCollum, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

Boston, Massachusetts

Charles E. Hatch, Tufts Dental School, Boston, Mass.
Ernest A. Hooton, Peabody Museum, Harvard College, Cambridge, Mass.
Philip A. Leavitt, 520 Beacon St., Boston, Mass.
Fred W. Morse, Harvard Medical School, Boston, Mass.
Benjamin Spector, Tufts Medical School, Boston, Mass.
Harry Trimble, Harvard Medical School, Boston, Mass.

[41] A list of the officers and members, as of March 15, 1928, was published in the last preceding issue of the *Journal of Dental Research*: 1928, viii, pp. 229–33. Since the adjournment of the Washington meeting, new sections have been organized successively in Pittsburgh, St. Louis, Halifax, Minnesota, and Philadelphia, in this order (June 8, 1928)

Chicago, Illinois

Lloyd Arnold, 1817 West Polk St., Chicago, Illinois
Olaf Bergeim, 1817 West Polk St., Chicago, Illinois
James R. Blayney, 1838 W. Harrison St., Chicago, Illinois
Hugh A. McGuigan, 1817 W. Polk St., Chicago, Illinois
Emil Mueller, 180 N. Michigan Av., Chicago, Illinois
Anna C. Nichols, 311 East Chicago Av., Chicago, Illinois
B. Orban, 1747 W. Harrison St., Chicago, Illinois
William F. Petersen, 1817 West Polk St., Chicago, Illinois
Burne O. Sippy, 1838 West Harrison St., Chicago, Illinois

Cleveland, Ohio

Samuel W. Chase, 2109 Adelbert Road, Cleveland, Ohio
Frederick C. Waite, 2109 Adelbert Road, Cleveland, Ohio

Halifax, Nova Scotia

J. Stanley Bagnall, Dental School, Dalhousie University, Halifax, Nova Scotia
Alden W. Faulkner, Dental School, Dalhousie University, Halifax, Nova Scotia
W. G. Dawson, Dental School, Dalhousie University, Halifax, Nova Scotia
Warren C. Oxner, Dental School, Dalhousie University, Halifax, Nova Scotia
Stephen G. Ritchie, Dental School, Dalhousie University, Halifax, Nova Scotia
Ralph P. Smith, Dental School, Dalhousie University, Halifax, Nova Scotia
*George Kerr Thomson, Dental School, Dalhousie University, Halifax, Nova Scotia.

Indianapolis, Indiana

Sherman L. Davis, 320 West 43rd St., Indianapolis, Indiana

* Secretary of the new section.

Iowa City, Iowa

A. W. Bryan, Dental School, University of Iowa, Iowa City, Iowa

Louisville, Kentucky

Theodore B. Beust, 129 E. Broadway, Louisville, Kentucky

Minnesota

Elmer S. Best, 801 Yeates Bldg., Minneapolis, Minnesota
Irwin A. Epstein, 403 Pittsburgh Bldg., St. Paul, Minnesota
Boyd S. Gardner, Mayo Clinic, Rochester, Minnesota
Carl J. Grove, 1007 Lowry Bldg., St. Paul, Minnesota
Herman A. Maves, 616 Donaldson Bldg., Minneapolis, Minnesota
Frederick S. Meyer, 812 Yeates Bldg., Minneapolis, Minnesota
George S. Monson, 405 Lowry Bldg., St. Paul, Minnesota
William D. Vehe, 1001 Yeates Bldg., Minneapolis, Minnesota
Carl W. Waldron, 730 La Salle Bldg., Minneapolis, Minnesota
*Daniel E. Ziskin, 326 La Salle Bldg., Minneapolis, Minnesota

New York City, N. Y.

Lester A. Cahn, 865 West End Av., N. Y. C.
Malcolm W. Carr, 667 Madison Av., N. Y. C.
Joseph D. Eby, 121 East 60th St., N. Y. C.
James M. Inouye, 437 West 59th St., N. Y. C.
Maxwell Karshan, 437 West 59th St., N. Y. C.
Frances Krasnow, 437 West 59th St., N. Y. C.
Harold J. Leonard, 302 East 35th St., N. Y. C.
John Oppie McCall, 121 East 60th St., N. Y. C.
Frederick S. McKay, 2 East 54th St., N. Y. C.
Edgar G. Miller, Jr., 437 West 59th St., N. Y. C.
Alfred Owre, 302 East 35th St., N. Y. C.
Bernhard W. Weinberger, 119 West 57th St., N. Y. C.

Philadelphia, Pennsylvania

Joseph L. T. Appleton, Jr., 4001 Spruce St., Philadelphia, Pa.
*Carrie K. Bryant, 44 Pennock Terrace, Lansdowne, Pa.
John A. Detlefsen, Swarthmore, Pa.

* Secretary of the new section.

Robert H. Ivy, Medical Arts Building, Philadelphia, Pa.
Joseph McFarland, 442 W. Stafford St., Germantown, Pa.
John V. Mershon, 1520 Spruce St., Philadelphia, Pa.
William R. Pentz, 605 Empire Bldg., Philadelphia. Pa.
Hermann Prinz, 40th and Spruce Sts., Philadelphia, Pa.
Arthur Hopewell Smith, Dental School, University of Pennsylvania, Philadelphia, Pa.
Charles R. Turner, Dental School, University of Pennsylvania, Philadelphia, Pa.

Pittsburgh, Pennsylvania

Thurlow W. Brand, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.
Frederick C. Friesell, Schenley Apartments, Oakland Station, Pittsburgh, Pa.
H. Edmund Friesell, Schenley Apartments, Oakland Station, Pittsburgh, Pa.
William F. Swanson, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.
*Lawrence E. Van Kirk, Jenkins Arcade, Pittsburgh, Pa.
Walter H. Wright, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

Rochester, New York

Philip Jay, 198 Genesee Park Blvd., Rochester, New York

St. Louis, Missouri

Benno E. Lischer, 4767 Westminster Place, St. Louis, Mo.
Elbert B. Owen, 335 Frisco Bldg., 906 Olive St., St. Louis, Mo.
*Clarence O. Simpson, University Club Bldg., St. Louis, Mo.
George B. Winter, 519 Frisco Bldg., St. Louis, Mo.

Toronto, Ontario

Thomas Cowling, 1 Grant St., Toronto, Canada

Washington, D. C.

F. E. Rodriguez, Army Medical School, Washington, D. C.

* Secretary of the new section.

ANNOUNCEMENTS

DANGEROUS TOOTH CLEANING FLUIDS

"Taxi" (Holland Specialty Co., Peoria, Ill.)

and

"Stain Remover" (Ransom and Randolph Co., Toledo, Ohio)

Advertised as non-injurious tooth-cleaning fluids, although rapidly destructive of enamel. See the findings of the Research Council of the New York Academy of Dentistry, and the comment by the manufacturers, in the *Journal of Dental Research*, 1927, vii, pp. 477–500.

ENDOWMENT FUND OF THE JOURNAL OF DENTAL RESEARCH

to receive the net proceeds of the sale of

"THE ORIGIN AND EVOLUTION OF THE HUMAN DENTITION"

By

WILLIAM K. GREGORY, A.M., Ph.D.

Curator of the Department of Comparative Anatomy, American Museum of Natural History, New York; Associate Professor of Vertebrate Palæontology, Columbia University

Illustrated with 15 plates and 353 figures
6 x 9 Cloth, gold stamped 548 pages
Detailed Index Full Bibliography

The "Origin and Evolution of the Human Dentition" is a masterly review of the essential facts relating to the origin and evolution of the teeth in man, by one of the best informed investigators in this field. The book presents a complete summary of the main facts in the palæontological record on the origin and evolution of human dentition; and is now regarded as the most notable and successful effort to epitomize this information, to reveal its full evolutional import, and to suggest its present practical significance. This review is a great fund of important facts and opinions in dental science, and, to be fully appreciated, must be studied in close comparison of the text with the many exceptional illustrations.

Of special interest to dentists, physicians, palæontologists, odontologists, morphologists, and students of evolution and inheritance.

The author has generously arranged for the sale of this book under conditions that will give the proceeds to the Endowment Fund of the Journal of Dental Research

Price: $6.00 net

May be ordered from

THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Journals and Books

BALTIMORE, U. S. A.

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Scientific meetings in 1927–28

Sectional meetings: Boston, November 8, February 10; *Chicago,* November 17, January 23, March 15, April 19, May 25; *Toronto,* November 21, February 6; *New York,* December 14, February 29; *San Francisco,* December 14.

Association: Sixth annual meeting, Washington, D. C., March 25–28. *Special meeting:* Minneapolis, Minn., on or about August 21, 1928.

All who are interested in dental research are invited to attend the scientific meetings of the Sections and of the Association.

INFORMATION FOR PROSPECTIVE SUBSCRIBERS OR CONTRIBUTORS

THE JOURNAL OF DENTAL RESEARCH, a journal of stomatology, is dedicated to the advancement of research, and to the dissemination of knowledge, pertaining to the teeth and mouth and to their relations to the body as a whole. It publishes original investigations and reviews in these fields, and in the sciences allied with or applied to them, and is issued bi-monthly, at the *ends* of the months of February, April, June, August, October, and December. Each volume contains at least 500 pages. The subscription price is $5.00.

This JOURNAL is the official publication medium of the dental organizations named on the title page of this cover. Although without a "policy," the JOURNAL represents an unwavering purpose to keep widely open the channel to freedom of *responsible* and *respectable* expression of truth and opinion, by individuals or organizations, without qualification by or for any views its editors individually may entertain. In accordance with this purpose, papers contributed by societies are controlled and edited by the respective associations through their official representatives.

THE JOURNAL OF DENTAL RESEARCH circulates widely among the most enlightened and progressive dentists and physicians, and among the leading libraries, thus assuring the degree and quality of publicity for its contents that the best dental literature merits. Therefore there can be no important occasion, except in very special cases, for the detailed presentation elsewhere of a paper published in this JOURNAL. Accordingly, to prevent waste of the JOURNAL'S resources in needless duplicate publication, and also to lighten the labors of students of the literature of dentistry, papers in this JOURNAL are not published in, or reprinted from, other dental journals, except for unusual professional reasons.

Authors of papers *on original research* will receive, free of charge, 50 reprints of their papers, *if they indicate a desire for them.* Copies in any number may be obtained at prices that will be quoted on request.

Address all communications relating to editorial matters to the JOURNAL OF DENTAL RESEARCH, 630 West 168th Street, New York City; business communications, to the JOURNAL OF DENTAL RESEARCH, Mount Royal and Guilford Avenues, Baltimore, Md.

CONTENTS

June, 1928

A tribute to Clarence Jones Grieves. *Harry E. Kelsey* 325
Some fundamental factors in tooth articulation. *Victor H. Sears,* D.D.S. 339
Mottled enamel. Report of an examination of an afflicted district in Italy. *Frederick S. McKay,* D.D.S. 353
Studies in the causes of dental anomalies. *W. G. Downs,* Jr., M.A., D.D.S. 367
Carnegie Foundation's "Bulletin No. 19" on dental education. Is it possible for a layman to offer opinions "adequate" for the improvement of dental education? *Albert L. Midgley,* D.M.D., Sc.D., F.A.C.D. 381
Analysis of state dental board examinations in the United States, with comparisons of failures of recent graduates. *F. C. Friesell,* D.D.S., F.A.C.D. 387
International Association for Dental Research. Scientific proceedings of the Sixth Annual Meeting: March 25–28, 1928. *William J. Gies,* F.A.C.D., *Secretary of the Committee on Organization* 395

WAVERLY PRESS, INC.
BALTIMORE, U. S. A.